DRAFT PRCP schedule

Environmental Protection Act 1994

P-PRCP-100758455 Blackwater Mine

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

PRCP schedule: P-PRCP-100758455_V2

PRCP schedule holder(s)

Name(s)	Registered address
Whitehaven Blackwater Pty Ltd	Level 28, 259 George Street SYDNEY NSW 2000
NS Blackwater Pty Limited	Level 14, 115 Pitt Street SYDNEY NSW 2000
JFE Steel Australia (BW) Pty Ltd	Level 28, 12 Creek Street BRISBANE CITY 4000

Location details

Location(s)
Mining Lease (ML) 1759, ML1760, ML1761, ML1762, ML1767, ML1771, ML1772, ML1773, ML1792, ML1800, ML1812, ML1829, ML1860, ML1862, ML1907, ML70091, ML70103, ML70104, ML70139, ML70167, ML70329

Take effect

In accordance with section 202B of the *Environmental Protection Act 1994* (EP Act), the PRCP schedule has effect on the day the environmental authority for carrying out relevant activities on land to which the schedule relates takes effect. Pursuant to section 202C of the EP Act, a PRCP schedule continues in force until the environmental authority for the relevant activities to which the PRCP schedule relates is cancelled or surrendered, even if the resource tenure expires or is cancelled and even if the relevant environmental authority is suspended under Chapter 5, part 11 or 11A of the EP Act.

	DATE
Signature	Date

Ben Byrd
Department of the Environment, Tourism, Science and Innovation
Delegate of the administering authority
Environmental Protection Act 1994

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Obligations under the *Environmental Protection Act 1994*

Pursuant to section 202E of the EP Act, if there is an inconsistency between an environmental authority and a PRCP schedule, the environmental authority prevails to the extent of the inconsistency.

Pursuant to section 285 of the EP Act:

- The holder of a PRCP schedule must commission an audit of the schedule by a rehabilitation auditor for the following periods (each an audit period) —
  - (a) The 3-year period starting on the day the schedule takes effect
  - (b) Each 3-year period starting on the day after the previous audit period ended.
- The holder must, within 4 months after the end of each audit period, give the administering authority –
  - (a) The rehabilitation auditor's report (an audit report) about the audit that complies with section 286 of the EP Act, and
  - (b) A declaration for the audit report that complies with section 285 of the EP Act.

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

PRCP schedule

The PRCP schedule incorporates the following sections:

- Section A – Conditions of PRCP schedule
- Section B – Definitions
- Section C – Final site design and reference maps
- Section D – Post mining land uses
- Section E – Non-use management areas.
- Section F – Attachments

Section A – Conditions of PRCP schedule

Pursuant to section 206A of the EP Act:

- It is a condition of this PRCP schedule that, in carrying out a relevant activity under the schedule, the holder must comply with a requirement stated in the environmental authority relevant to carrying out the activity.
- It is a condition of this PRCP schedule that the holder must comply with the following matters stated in the schedule –
  - (a) Each rehabilitation milestone and management milestone
  - (b) When each rehabilitation milestone and management milestone is to be achieved

General conditions

PRCP1 For each rehabilitation and improvement area the holder must achieve the rehabilitation or management milestone criteria (milestone reference):

(a) for the cumulative area available specified in this schedule; and

(b) by the milestone completion date specified in this schedule.

PRCP2 Where a land area ≥50 hectares becomes 'available for rehabilitation' earlier than **twelve (12) months** prior to the milestone date nominated in this schedule, the holder must seek an amendment to the schedule under s.215 (1) (b) of the EP Act within **60 business days** of the land being made available.

PRCP3 Where an area achieves a rehabilitation or management milestone, the holder must continue to achieve the milestone criteria until a surrender is approved.

PRCP4 The holder must maintain a risk register that identifies the risks to not achieving:

(a) a stable condition for post-mining land uses (PMLUs); or

(b) sufficient improvement for non-use management areas (NUMAs);

and how the risks are being managed or minimised.

PRCP5 The risk register required under **PRCP4** must be reviewed annually and include consideration of the outcomes of PRCP monitoring data.

PRCP6 The holder must carry out monitoring in accordance with:

(a) any requirement under this schedule; and

(b) as necessary to demonstrate achievement of each rehabilitation milestone or management milestone criteria.

PRCP7 The holder must make and keep up to date records on:

(a) Achievement and ongoing maintenance of each rehabilitation or management milestone criteria relating to this schedule;

(b) Rehabilitation activities and the results of those activities (including but not limited to, actions taken, date, location, methods, data collected, Quality Assurance/Quality Control, photos, waste tracking and disposal records, appropriately qualified person details and assumptions);

(c) Maintenance of rehabilitation and the results of maintenance activities;

(d) Monitoring of rehabilitation and the results of monitoring;

(e) Details and results of rehabilitation trials;

(f) Relevant designs, drawings, specifications and any similar documents developed in accordance with good professional practice in relation to rehabilitation milestones or milestone criteria;

(g) All documents in relation to the requirements of this schedule, including reports (e.g. site investigation report), statements (e.g. site suitability statement), certifications, assessments, investigations, inspections, audits or any similar documents developed in relation to rehabilitation milestones or milestone criteria;

(h) Landholder agreements;

(i) Details of community consultation (to be documented in the community consultation register) relating to rehabilitation and closure activities.

Note: It is acknowledged that for works that pre-date this PRCP schedule (i.e. RA6 and RA7 – Existing Rehabilitation), there may be records that will not have been taken or kept, but all relevant records that do exist will be included.

PRCP8 Records made under **PRCP7** must be kept until the relevant environmental authority has been surrendered or cancelled.

PRCP9 Records made under **PRCP7** must be provided to the administering authority in the specified format within **10 business days** of a written request.

PRCP10 All Appropriately Qualified Person (AQP) / Suitably Qualified Person (SQP) designs, specifications, certifications, assessments and any similar documents, must:

(a) include documented consideration of any relevant guideline or publication material, including material published by the administering authority;

(b) detail the boundary conditions (of any model);

(c) detail any assumptions made, limitations and areas of uncertainty; and

(d) must contain sufficient detail to allow for independent peer review and substantiation.

PRCP11 Disturbance due to exploration and minor ancillary activities in areas not planned to be mined and not within a Rehabilitation Area in this Schedule must be rehabilitated in accordance with the provisions detailed in the 'Eligibility criteria and standard conditions for exploration and mineral development projects' or its successor, with the exception that land must be rehabilitated to a stable condition which includes achieving the relevant post mining land use for the disturbance location as detailed in **Figure 1 – Final Site Design**.

Closure landform design report

PRCP12 By **1 July 2028**, the holder must provide to the administering authority an AQP prepared Closure Landform Design Report that incorporates all relevant structures and watercourse diversion designs, and is certified by the independent AQP as being safe, erosionally and structurally stable, appropriate for the applicable PMLU or NUMA, and contains a suitable level of detail with respect to planned execution timing. The Closure Landform Design Report must have regard for the material properties and local conditions as they apply to geotechnical and erosional stability risk.

The Closure Landform Design Report must include performance criteria that demonstrate that the landform will support the achievement of a stable condition.

PRCP13 The currency of the Closure Landform Design Report must be maintained, and the report updated as often as necessary to reflect any material changes to the design that may affect the ability to achieve or sustain a stable landform condition.

Where material changes to the design have been made, the report is to be recertified by an AQP in accordance with **PRCP12**.

PRCP14 By **1 July 2030**, the holder must submit to the administering authority an RPEQ prepared Design Plan for the permanent Sirius Creek watercourse diversion, prepared in accordance with the guideline titled *Works that interfere with water in a watercourse for a resource activity—watercourse diversions authorised under the Water Act 2000 (OSW/2019/4599)* (DNRME 2019), or the latest revision of that guideline.

An RPEQ prepared Design Plan for the remaining permanent diversions must be submitted to the administering authority 24 months prior to construction.

Each Design Plan must align with the PMLU identified in the PRCP schedule, demonstrate that the diversion alignment will achieve a stable condition, and be consistent with the Closure Landform Design Report required by **PRCP12**. The Design Plan must also demonstrate that the diversion will not prevent any flood protection landforms from achieving the outcomes required by **PRCP15, PRCP16** or **RM3.12**.

Flood susceptibility and impact assessment

PRCP15 By **1 July 2031**, the holder must submit to the administering authority a flood susceptibility and impact assessment prepared and certified by an independent AQP. The assessment must:

(a) Update the flood model to include the following:

(i) revised hydrology model parametrisation based on the best available data at the time;

(ii) the final landform topography current at the time, including best available data for features such as diversions, voids, and flood protection landforms; and

(iii) modelling assumptions that do not introduce artificial hydraulic constraints or inhibit realistic flood ingress or connectivity pathways.

(b) Describe potential risks and impacts under extreme flood events up to and including PMF events, including quantifying potential interactions between residual voids, permanent diversions, flood protection landforms, dams, adjacent floodplains and the receiving environment. The assessment must consider backwatering, overtopping, flood ingress pathways and erosion-driven failure mechanisms for the following final landform features:

(i) Diversions: Sirius Creek (as shown in Figure 4)

(ii) Residual voids adjacent to above diversion (i.e. R74) (as shown in Figure 4).

(c) For the Sirius Creek diversion and associated R74 residual void, describe the potential impacts of extreme events up to and including PMF event on flood protection landforms, including:

(i) risks to achieving stable conditions; and

(ii) the potential for serious environmental harm to the receiving environment that is:

(1) irreversible, of a high impact or widespread[1]; and

[1] Section 17(1) of the *Environmental Protection Act 1994*

(2) significantly different to impacts expected on the surrounding environment exposed to the flood.

(d) For the Sirius Creek Diversion and R74 residual void, include a Consequence Category Assessment (CCA) for extreme flood events up to and including PMF event, undertaken in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933) (or later version).

(e) Demonstrate how the current or proposed design of flood protection landforms will prevent serious environmental harm to the receiving environment that is significantly different to impacts expected on the surrounding environment exposed to the flood.

PRCP16 By **1 July 2032**, if the flood susceptibility and impact assessment required by **PRCP15** identifies requirements for new flood protection measures or material modifications to existing flood protection landforms, the holder must submit to the administering authority an updated AQP prepared and certified Closure Landform Design Report and Design Plans for applicable permanent watercourse diversions that implement the measures and material modifications identified in **PRCP15** and:

(a) Demonstrate that the updated design achieves flood immunity for the 0.1% AEP event with minimum stability criteria, crest elevations and freeboard requirements clearly defined; and

(b) For the Sirius Creek Diversion and associated R74 residual void, demonstrate that the updated design achieves flood immunity for:

(i) a 0.1% AEP event; or

(ii) if the CCA required by **PRCP15(d)** determines a consequence category of “high” for ‘harm to humans’ or ‘general environmental harm’ for ‘Failure to contain – overtopping’ or ‘Dam break’ failure event scenarios, a design event less likely than a 0.1% AEP event, as determined by an AQP to be appropriately protective, with minimum stability criteria, crest elevations and freeboard requirements clearly defined.

(c) Demonstrate how the Design Plans will achieve the following for the level of risk identified:

(i) Hydraulic stability;

(ii) Erosional stability; and

(iii) Geotechnical stability.

PRCP17 Within 12 months of submitting an AQP prepared Design Plan for a remaining permanent diversion, as required by **PRCP14**, the holder must submit to the administering authority a flood susceptibility and impact assessment according to the requirements of **PRCP15** updated to include changes to the final landform from the Design Plan. If the updated flood susceptibility and impact assessment identifies requirements for new flood protection measures or material modifications to existing flood protection landforms, the holder must at the same time submit to the administering authority an updated AQP prepared and certified Closure Landform Design Report and Design Plan as per the requirements of **PRCP16**.

Flood modelling

PRCP18 By **1 July 2124**, the holder must submit to the administering authority updated flood modelling (up to and including PMF events) incorporating the as-constructed final landform and calibrated against the closure landform design.

Groundwater modelling

PRCP19 An up-to-date closure groundwater and water balance model (calibrated once data becomes available) must be maintained with predictions rerun at least every 5 years, from the date of approval of the PRCP and within one year prior to any surrender application.

PRCP20 By **1 July 2044,** the holder must submit to the administering authority updated long term post-mining prediction numerical modelling for drawdown and groundwater level elevations. The predictive groundwater modelling as per the Australian Groundwater Modelling Guidelines (current version), confirms:

(a) The residual voids will not cause environmental harm through the release of contaminants from the void lakes beyond the tenure boundaries post-closure;

(b) Any seepage from spoil dumps will not cause environmental harm through the release of contaminants beyond the tenure boundaries post-closure; and

(c) Groundwater drawdown will not negatively impact groundwater dependent ecosystems (GDEs) on or surrounding the site.

Progressive Rehabilitation Certification

PRCP21 The requirements for achievement of progressive rehabilitation certification do not include the requirements of **RM7.5-7.8** and **RM8**.

Water quality limits

PRCP22 By **18 May 2029**, the holder must apply to amend the interim surface and groundwater quality trigger levels in **Attachment 7 – Interim Surface Water Quality Trigger Levels** and **Attachment 9 – Interim Groundwater Quality Trigger Levels** with sufficient site-specific supporting data and proposed limits appropriate to detect changes and demonstrate achievement of stable condition.

END OF CONDITIONS

Section B – Definitions

Appropriately qualified person (AQP)	means a person who has professional qualifications, training, skills and 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.
Activity (EP Regulation)	includes that part, if any, of an activity relating to the following— (a) preparing a place for the activity before carrying out the activity; (b) rehabilitating a place after it has been used for carrying out the activity.
BioCondition	refers to the *BioCondition Assessment Manual* (Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. (2015)) and *BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.2* (Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane) or later versions thereof.
Contaminants	can be a gas, liquid or solid; or an odour; or an organism (whether alive or dead), including a virus; or energy, including noise, heat, radioactivity and electromagnetic radiation; or a combination of contaminants.
Contaminated Land Auditor	A contaminated land auditor is responsible for auditing the work of the suitably qualified person (SQP) by evaluating and certifying site investigation and validation reports and drafting the site management plans that are submitted for a decision on a land contamination matter.
Environmentally problematic material	means material that will negatively impact water quality and stability or vegetation growth.
Flood stress	is the pressure on structures from rapid water rise, erosion, and saturation during extreme floods, risking instability.
Groundcover	means anything in contact with the soil surface including live cover, standing dry cover, organic litter (including leaves, hay, woody debris) or rocks.
Growth media	is defined as all soil and soil-like material that will support the final vegetation cover. This includes the topsoil and subsoil where these materials are applied independently. Where the topsoil is incorporated into the underlying subsoil/spoil, topsoil refers to the depth of incorporation and the remaining depth is regarded as subsoil. The total depth of growth media is nominally considered to be the effective plant root zone
Gully	A gully is a channel excavated by water, more than 0.3 m deep.
Independent AQP	is an AQP who is a third party, being independent of the PRCP schedule holder, and has not previously provided advice on the matter the subject of the review.

Independently peer reviewed	means an AQP who is a third-party to the PRCP schedule holder and the AQP whose report is being reviewed and substantiated. The peer reviewer's documentation provided must contain sufficient detail to allow for further independent technical review and substantiation, and provide and justify site-specific performance (SMART) criteria, if required.
Potentially acid forming (PAF)	means material with either a Net Acid Producing Potential of greater than 5 kg of H_2SO_4/tonne or a Net Acid Generation oxidation pH of less than 4.5 (pH unit).
Registered Professional Engineer of Queensland (RPEQ)	Means a person who is registered under the *Professional Engineers Act 2002 (Qld)* and is competent in the relevant area of engineering practice for the matters being undertaken as required under the PRCP Schedule.
Rehabilitation activity	means any activity that the holder is required to carry out in relation to this PRCP schedule.
Relevant material	includes: i. Final landform design report, ii. Durability assessment/ report, iii. "As Constructed" report; iv. All monitoring data v. Assessment of monitoring data, vi. All maintenance records; and vii. Modelling and technical assessments.
Relevant structure	Overburden/spoil emplacements, waste rock dumps, tailings storage facilities, residual voids and flood protection landforms.
Rill	A rill is a channel excavated by water, less than 0.3 m deep.
Stable	in relation to land, means landform dimensions are or will be stable within tolerable limits now and in the foreseeable future. Stability includes consideration of environmental context, geotechnical stability, settlement and consolidation allowances, bearing capacity (trafficability), erosion resistance and geochemical stability with respect to seepage, leachate and related contaminant generation.
Stabilised	means one or both of the following conditions apply: no evidence of sediment movement; sides and/or floors of erosion form are revegetated (Australian Soil and Land Survey Field Handbook Fourth Edition).
Stable condition	see section 111A of the *Environmental Protection Act 1994*.

Suitably qualified person (SQP)	for performing a regulatory function under chapter 7, part 8 (Contaminated Land) of the EP Act or another function prescribed under a regulation, means a person who— (a) has qualifications and experience relevant to performing the function; and (b) if a regulation prescribes an organisation for this paragraph—is a member of the organisation.
Vegetative groundcover	Means plants, plant litter, tree leaf litter, twigs and woody debris capable of protecting the soil surface from erosion.
Weed	(a) Category 3 restricted invasive plant species, defined by the *Biosecurity Act 2014*; and (b) Weeds of Natural Significance, defined by Invasive Plants and Animals Committee 2016, Australian Weeds Strategy 2017 to 2027, Australian Government Department of Agriculture and Water Resources, Canberra.

Section C – Final site design and reference maps

Figure 1 – Final Site Design: North Area

Figure 2 – Final Site Design: South Area

Figure 3 – Reference Map: North Area

Figure 4 – Reference Map: South Area

Figure 1 – Final Site Design: North Area

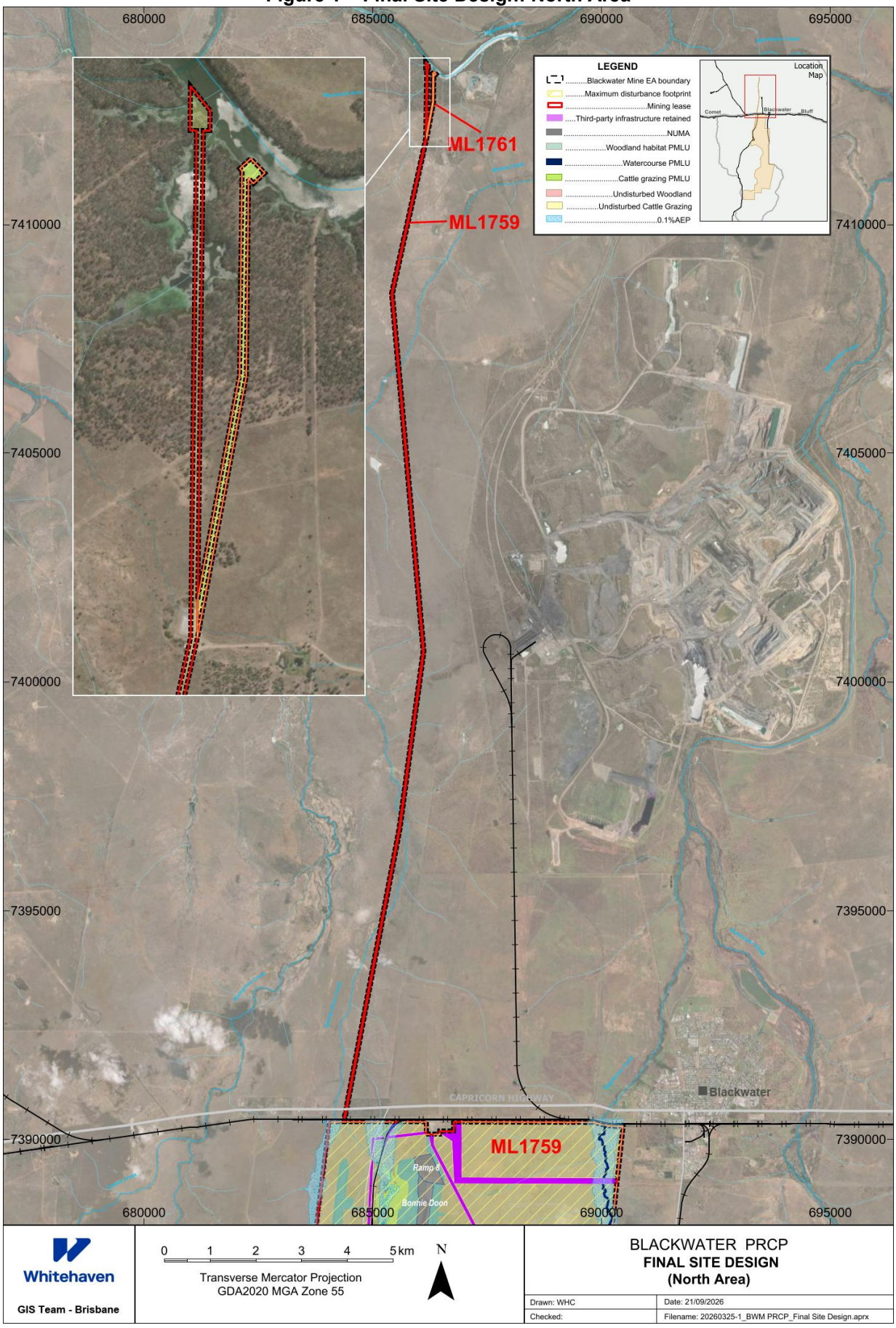


Figure 2 – Final Site Design: South Area

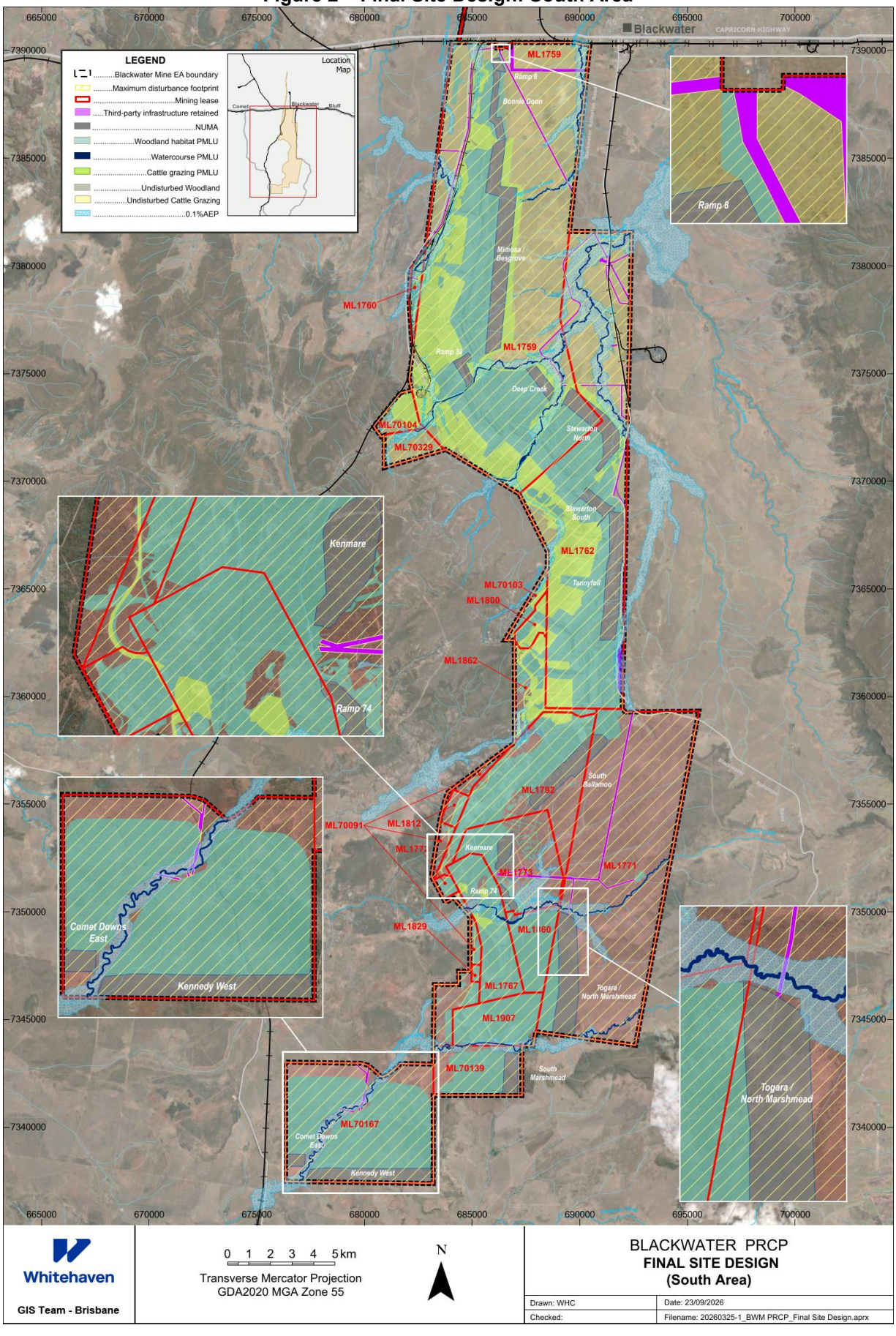


Figure 3 – Reference Map: North Area

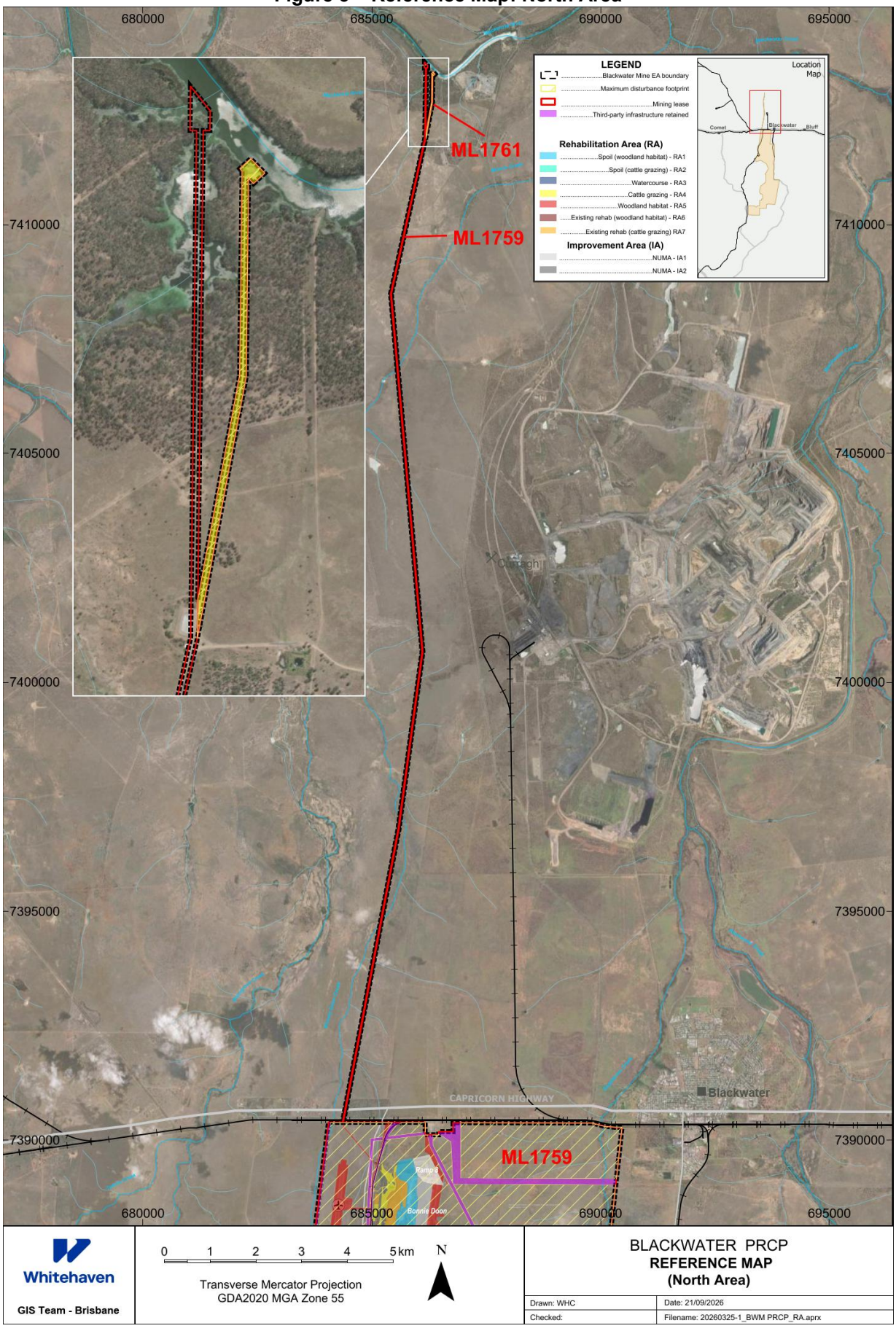
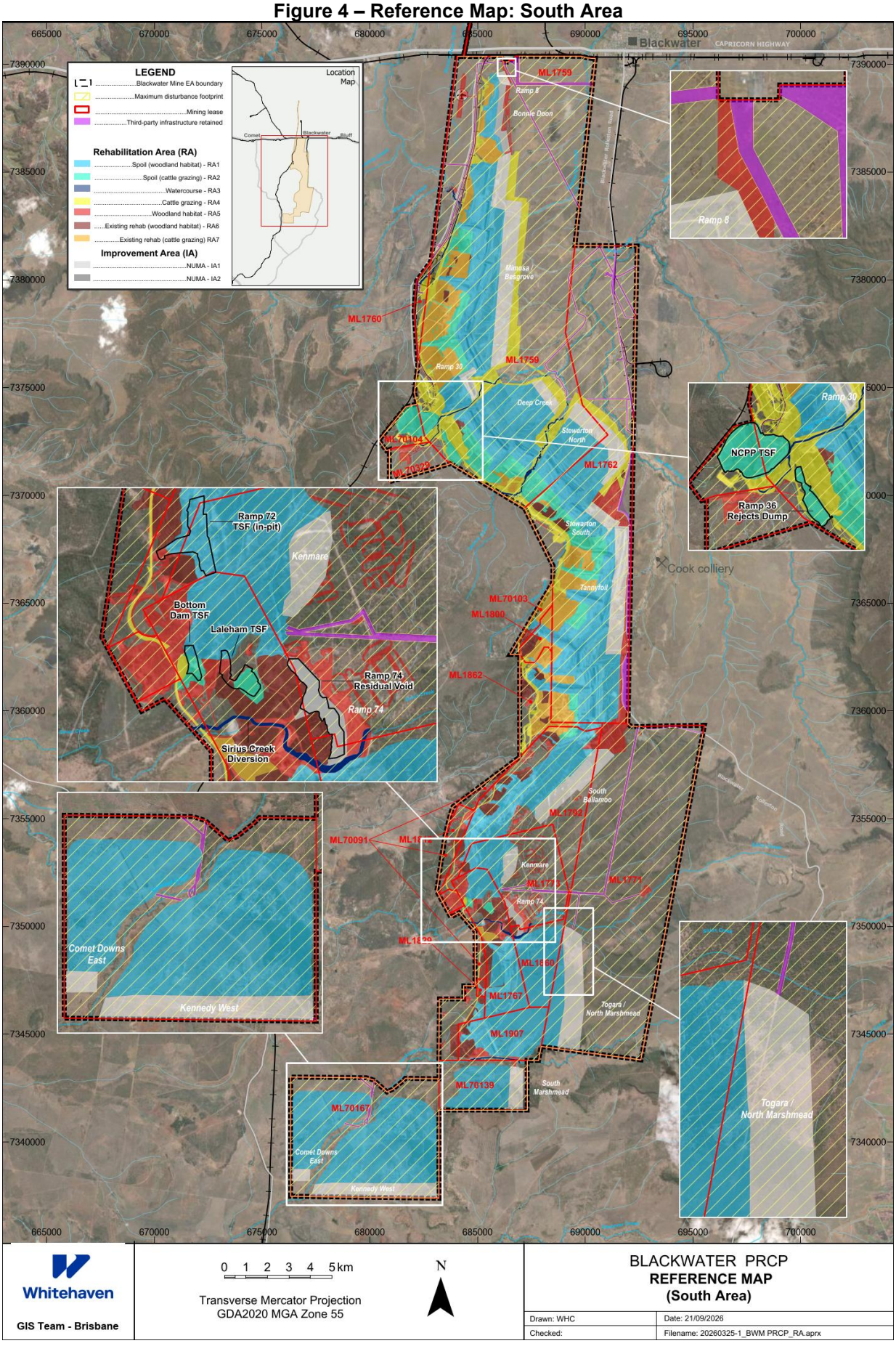


Figure 4 – Reference Map: South Area



Section D – Post mining land uses

(RA1) Rehabilitation area 1

Post-mining land uses (PMLU)																											
Rehabilitation area	RA1																										
Relevant activities	Spoil Dumps and Tailings Storage Facility (TSF) (Ramp 72 TSF)																										
Total rehabilitation area size (ha)	11,897																										
Commencement of first milestone: RM1	01-Jul-2035																										
PMLU	Woodland Habitat																										
Date area is available	1/07/2035	1/07/2040	1/07/2045	1/07/2050	1/07/2055	1/07/2060	1/07/2065	1/07/2070	1/07/2075	1/07/2080	1/07/2085	1/07/2090	1/07/2095	1/07/2100	1/07/2105	1/07/2110	1/07/2115	1/07/2120									
Cumulative area available (ha)	458	1,083	1,628	2,277	2,947	3,614	4,282	5,042	5,927	6,812	7,610	8,380	9,129	9,464	10,134	10,799	11,485	11,897									
Milestone completed by	10/12/2040	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090	10/12/2095	10/12/2100	10/12/2105	10/12/2110	10/12/2115	10/12/2120	10/12/2125	10/12/2130	10/12/2135	10/12/2140	10/12/2145	10/12/2150	10/12/2155	10/12/2160		
Milestone Reference	Cumulative area achieved (ha)																										
RM1	458	1,083	1,628	2,277	2,947	3,614	4,282	5,042	5,927	6,812	7,610	8,380	9,129	9,464	10,134	10,799	11,485	11,897									
RM2	458	1,083	1,628	2,277	2,947	3,614	4,282	5,042	5,927	6,812	7,610	8,380	9,129	9,464	10,134	10,799	11,485	11,897									
RM3	458	1,083	1,628	2,277	2,947	3,614	4,282	5,042	5,927	6,812	7,610	8,380	9,129	9,464	10,134	10,799	11,485	11,897									
RM4	208	865	1,410	2,007	2,679	3,347	4,015	4,722	5,573	6,458	7,343	8,031	8,834	9,196	9,866	10,536	11,201	11,897									
RM5		587	1,192	1,737	2,411	3,080	3,748	4,456	5,219	6,104	6,989	7,743	8,555	9,157	9,598	10,268	10,933	11,615	11,897								
RM6			587	1,192	1,737	2,411	3,080	3,748	4,456	5,219	6,104	6,989	7,743	8,555	9,157	9,598	10,268	10,933	11,615	11,897							
RM7							587	1,192	1,737	2,411	3,080	3,748	4,456	5,219	6,104	6,989	7,743	8,555	9,157	9,598	10,268	10,933	11,615	11,897			
RM8																									11,897		

(RA2) Rehabilitation area 2

Post-mining land uses (PMLU)																							
Rehabilitation area	RA2																						
Relevant activities	Spoil Dumps and TSFs/Rejects (NCPP TSF, Laleham TSF, Bottom Dam TSF, R36 Rejects)																						
Total rehabilitation area size (ha)	1,538																						
Commencement of first milestone: RM1	01-Jul-2026																						
PMLU	Cattle Grazing																						
Date area is available	1/07/2026	1/07/2028	1/07/2030	1/07/2032	1/07/2035	1/07/2040	1/07/2045	1/07/2050	1/07/2055	1/07/2060	1/07/2065	1/07/2070	1/07/2075	1/07/2080	1/07/2085	1/07/2090	1/07/2095	1/07/2100					
Cumulative area available (ha)	305	615	866	1,126	1,244	1,244	1,244	1,244	1,244	1,244	1,244	1,298	1,298	1,298	1,298	1,298	1,314	1,538					
Milestone completed by	10/12/2028	10/12/2030	10/12/2032	10/12/2035	10/12/2040	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090	10/12/2095	10/12/2100	10/12/2105	10/12/2110	10/12/2115	10/12/2120	10/12/2125	10/12/2160
Milestone Reference	**Cumulative area achieved (ha)**																						
RM1	305	615	866	1,126	1,244	1,244	1,244	1,244	1,244	1,244	1,244	1,298	1,298	1,298	1,298	1,298	1,314	1,538					
RM2	305	615	866	1,126	1,244	1,244	1,244	1,244	1,244	1,244	1,244	1,298	1,298	1,298	1,298	1,298	1,314	1,538					
RM3	305	615	866	1,126	1,244	1,244	1,244	1,244	1,244	1,244	1,244	1,298	1,298	1,298	1,298	1,298	1,314	1,538					
RM4		305	615	978	1,236	1,244	1,244	1,244	1,244	1,244	1,244	1,298	1,298	1,298	1,298	1,298	1,298	1,538					
RM5			305	775	1,196	1,244	1,244	1,244	1,244	1,244	1,244	1,244	1,298	1,298	1,298	1,298	1,298	1,419	1,538				
RM6					775	1,196	1,244	1,244	1,244	1,244	1,244	1,244	1,244	1,298	1,298	1,298	1,298	1,298	1,419	1,538				
RM7							775	1,196	1,244	1,244	1,244	1,244	1,244	1,244	1,244	1,298	1,298	1,298	1,298	1,298	1,419	1,538		
RM8																							1,538

(RA3) Rehabilitation area 3

Post-mining land uses (PMLU)																								
Rehabilitation area	RA3																							
Relevant activities	Creek Diversions and Crossings																							
Total rehabilitation area size (ha)	136																							
Commencement of first milestone: RM1	01-Jul-2032																							
PMLU	Watercourse																							
Date area is available	1/07/2032	1/07/2035	1/07/2040	1/07/2045	1/07/2050	1/07/2055	1/07/2060	1/07/2065	1/07/2070	1/07/2075	1/07/2080	1/07/2085	1/07/2090	1/07/2095	1/07/2100	1/07/2105	1/07/2110								
Cumulative area available (ha)	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	136							
Milestone completed by	10/12/2035	10/12/2040	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090	10/12/2095	10/12/2100	10/12/2105	10/12/2110	10/12/2115	10/12/2120	10/12/2125	10/12/2130	10/12/2135	10/12/2140	10/12/2145	10/12/2160	
Milestone Reference	Cumulative area achieved (ha)																							
RM1	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	136							
RM2	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	136							
RM3	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	136							
RM4		28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	136						
RM5		28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	136						
RM6			28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	136					
RM7							28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	136	
RM8																							136	

(RA4) Rehabilitation area 4

Post-mining land uses (PMLU)																									
Rehabilitation area	RA4																								
Relevant activities	Infrastructure areas (CHPP North, coal stockpiles, TLO, Thermal Coal Plant, workshops, administration buildings, laydown yards, roads, mine water dams)																								
Total rehabilitation area size (ha)	2,029																								
Commencement of first milestone: RM1	01-Jul-2030																								
PMLU	Cattle Grazing																								
Date area is available	1/07/2030	1/07/2032	1/07/2035	1/07/2040	1/07/2045	1/07/2050	1/07/2055	1/07/2060	1/07/2065	1/07/2070	1/07/2075	1/07/2080	1/07/2085	1/07/2090	1/07/2095	1/07/2100	1/07/2105	1/07/2110	1/07/2115	1/07/2120	1/07/2125					
Cumulative area available (ha)	23	53	144	269	474	504	547	764	982	1,025	1,025	1,025	1,025	1,050	1,173	1,393	1,613	1,836	1,898	1,964	2,029					
Milestone completed by	10/12/2032	10/12/2035	10/12/2040	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090	10/12/2095	10/12/2100	10/12/2105	10/12/2110	10/12/2115	10/12/2120	10/12/2125	10/12/2130	10/12/2135	10/12/2140	10/12/2145	10/12/2150	10/12/2160
Milestone Reference																									
RM1	23	53	144	269	474	504	547	764	982	1,025	1,025	1,025	1,025	1,050	1,173	1,393	1,613	1,836	1,898	1,964	2,029					
RM2	23	53	144	269	474	504	547	764	982	1,025	1,025	1,025	1,025	1,050	1,173	1,393	1,613	1,836	1,898	1,964	2,029					
RM3		23	102	187	392	504	504	677	895	1,018	1,025	1,025	1,025	1,043	1,129	1,305	1,525	1,745	1,898	1,944	2,029					
RM4			80	165	310	504	504	590	808	984	1,025	1,025	1,025	1,025	1,053	1,217	1,437	1,657	1,879	1,898	2,029					
RM5			53	123	228	433	504	504	721	938	1,025	1,025	1,025	1,025	1,047	1,129	1,349	1,569	1,793	1,898	1,955	2,029				
RM6				53	123	228	433	504	504	721	938	1,025	1,025	1,025	1,025	1,047	1,129	1,349	1,569	1,793	1,898	1,955	2,029			
RM7						53	123	228	433	504	504	721	938	1,025	1,025	1,025	1,025	1,047	1,129	1,349	1,569	1,793	1,898	1,955	2,029	
RM8																										2,029

(RA5) Rehabilitation area 5

Post-mining land uses (PMLU)																										
Rehabilitation area	RA5																									
Relevant activities	Infrastructure areas (CHPP South, coal stockpiles, roads, laydown yards, workshops, administration buildings, mine water dams, exploration, historic subsidence areas)																									
Total rehabilitation area size (ha)	1,355																									
Commencement of first milestone: RM1	01-Jul-2030																									
PMLU	Woodland Habitat																									
Date area is available	1/07/2030	1/07/2032	1/07/2035	1/07/2040	1/07/2045	1/07/2050	1/07/2055	1/07/2060	1/07/2065	1/07/2070	1/07/2075	1/07/2080	1/07/2085	1/07/2090	1/07/2095	1/07/2100	1/07/2105	1/07/2110	1/07/2115	1/07/2120							
Cumulative area available (ha)	35	169	255	255	255	438	610	610	610	637	637	637	724	818	818	818	818	818	955	1,355							
Milestone completed by	10/12/2032	10/12/2035	10/12/2040	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090	10/12/2095	10/12/2100	10/12/2105	10/12/2110	10/12/2115	10/12/2120	10/12/2125	10/12/2130	10/12/2135	10/12/2140	10/12/2145	10/12/2150	10/12/2155	10/12/2160
Milestone Reference	**Cumulative area achieved (ha)**																									
RM1	35	169	255	255	255	438	610	610	610	637	637	637	724	818	818	818	818	818	955	1,355							
RM2	35	169	255	255	255	438	610	610	610	637	637	637	724	818	818	818	818	818	955	1,355							
RM3		72	255	255	255	352	567	610	610	610	637	637	637	818	818	818	818	818	885	1,022	1,355						
RM4			224	255	255	266	481	610	610	610	637	637	637	768	818	818	818	818	818	1,002	1,355						
RM5			107	255	255	255	395	610	610	610	637	637	637	681	818	818	818	818	818	928	1,187	1,355					
RM6				107	255	255	255	395	610	610	610	637	637	637	681	818	818	818	818	818	928	1,187	1,355				
RM7								107	255	255	255	395	610	610	610	637	637	637	681	818	818	818	818	818	928	1,187	1,355
RM8																											1,355

(RA6) Rehabilitation area 6

Post-mining land uses (PMLU)										
Rehabilitation area	RA6									
Relevant activities	Existing Rehabilitation									
Total rehabilitation area size (ha)	944									
Commencement of first milestone: RM6	01-Jul-2026									
PMLU	Woodland Habitat									
Date area is available	1/07/2026	1/07/2028	1/07/2030	1/07/2032	1/07/2035					
Cumulative area available (ha)	575	575	633	727	944					
Milestone completed by	10/12/2028	10/12/2030	10/12/2032	10/12/2035	10/12/2040	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2160
Milestone Reference	**Cumulative area achieved (ha)**									
RM6	575	575	633	727	944					
RM7	45	45	45	45	45	45	575	727	944	
RM8										944

(RA7) Rehabilitation area 7

Post-mining land uses (PMLU)								
Rehabilitation area	RA7							
Relevant activities	Existing Rehabilitation							
Total rehabilitation area size (ha)	1,910							
Commencement of first milestone: RM6	01-Jul-2026							
PMLU	Cattle Grazing							
Date area is available	1/07/2026							
Cumulative area available (ha)	854							
Milestone completed by	10/12/2028	10/12/2030	10/12/2032	10/12/2035	10/12/2040	10/12/2045	10/12/2050	10/12/2160
Milestone Reference	**Cumulative area achieved (ha)**							
RM6	854	854	1,489	1,800	1,910			
RM7					854	1,800	1,910	
RM8								1,910

Rehabilitation area milestones

Milestone reference	Rehabilitation milestone	Milestone criteria
RM1	Infrastructure decommissioning and removal	**1.1** With the exception of any infrastructure to remain as part of the post-mining land use (PMLU), or where infrastructure is agreed to be retained by the landholder as evidenced by a signed landholder agreement, the following are to be completed: (a) **Services and utilities:** Disconnect and remove all above and below ground services (water, electricity, gas etc) and ensure no service infrastructure remains within 0.5m of the final landform surface. All pipelines are to be drained. (b) **Buildings and structures:** Dismantle and remove all buildings, fencing, associated foundations and related materials to within 0.5m of the final landform surface. Dispose of such materials on-site only if they are a type of waste authorised under Environmental Authority EPML00717813. All other materials must be transported for lawful disposal off-site. (c) **Hardstands and roads:** Remove all hardstand, concrete, roads and road construction materials (bitumen, blue metal, aggregate etc) to within 0.5m of the final landform surface. Dispose of such materials on-site only if they are a type of waste authorised under Environmental Authority EPML00717813. All other materials must be transported for lawful disposal off-site. (d) **Drainage and water infrastructure:** All dams dewatered and desilted, and dam liners removed. Remove all surface water drainage infrastructure (including watercourse crossings and culverts) that do not form part of a watercourse or riparian ecosystem PMLU, or form part of a non-use management area (NUMA). (e) **Earthworks and other features:** Decommission all drillholes, bores (not used for the purposes of monitoring as defined in this schedule), sediment ponds and sumps. (f) **Machinery and equipment:** Remove all plant and equipment not required for rehabilitation works from site. (g) **Waste materials:** Remove all waste not authorised for on-site disposal under Environmental Authority EPML00717813.

Milestone reference	Rehabilitation milestone	Milestone criteria
		(h) **Historical underground areas:** Underground related surface and access-point infrastructure to be removed in accordance with AQP recommendations. Hardstand, concrete and structural components (for example shaft collars, steel arches and lagging bords) are to be removed if they occur within 0.5m of the final landform surface, or as prescribed by an AQP. **1.2** Independent AQP certifies achievement of **RM1.1**.
RM2	Identification, remediation and removal of contaminated land	**2.1** Contaminated land investigations (investigation, remediation and validation) completed in accordance with the *Environmental Protection Act 1994*, including a site investigation report, and where required, a Validation Report and/or a draft Site Management Plan, except for waste disposed of as authorised under Environmental Authority EPML00717813. **2.2** Contaminated and hazardous material is either remediated in-situ or disposed of on-site to the extent authorised under Environmental Authority EPML00717813, or removed and disposed of to an approved landfill, with waste tracking information recorded and submitted. **2.3** Contaminated Land Auditor certifies that any contamination other than that authorised in **RM2.1** will not have a material impact on the achievement of the relevant PMLU.
RM3	Landform development (re-profiling / reshaping)	**Criteria applicable to all RAs:** **3.1** Relevant structures and permanent diversions are developed and/or reshaped such that they are consistent with the Closure Landform Design Report (**PRCP12**) and Design Plan (**PRCP14**), and the remainder of disturbed land is reshaped appropriately as determined by an AQP. **3.2** All major earthworks (including reshaping, pushing, trimming etc) are undertaken in accordance with the Closure Landform Design Report and/or area-specific detailed design prepared and certified by an AQP. **3.3** Where an area-specific detailed design is constructed per **RM3.2**, an “As-Constructed Report” for the area is required which informs of the variations from the Closure Landform Design Report, and certifies that such variations will not adversely affect the achievement of a safe and stable landform condition.

Milestone reference	Rehabilitation milestone	Milestone criteria
		3.4 Erosion and sediment controls must be installed in accordance with the AQP certified Closure Landform Design Report for relevant structures (**PRCP12**), or AQP certified alternative designs (**RM3.2**), and/or permanent watercourse diversion Design Plan (**PRCP14**). **3.5** Constructed landforms achieve geotechnical stability with a Factor of Safety (FOS) ≥ 1.5 at the safety bund unless an alternative is justified by an AQP. **Additional PMLU specific landform criteria:** **3.6** For the Cattle Grazing PMLU, landforms are reshaped with: (a) at least 70% of slopes ≤20% gradient. (b) at least 50% of slopes ≤15% gradient; and (c) no slopes ≥25% gradient. **3.7** For the Woodland Habitat PMLU, landforms reshaped to ≤30% gradient. **3.8** For the Watercourse PMLU: (a) 'As constructed' plans prepared by an AQP demonstrate that diversions are constructed in accordance with the engineered design plan developed in accordance with condition **PRCP14**. (b) Disturbed natural watercourse bed and banks are returned to a profile similar to the pre-disturbance condition, or if unknown, similar to condition of comparable regional watercourses as informed by an AQP. **Additional criteria for tailings storage facilities (TSFs) and reject dumps:** **3.9** All tailings and rejects are to be encapsulated by at least 1m of consolidated non-acid forming (NAF) material, unless an alternative is recommended by an AQP. **3.10** Any detailed cover system designs for TSFs and reject dumps prepared by an AQP must consider the physicochemical properties of the waste material being stored, the availability of suitable cover materials and the specific location, hydrogeology and geometry of each structure. In the absence of an AQP designed cover system, the following concept design criteria apply:

Milestone reference	Rehabilitation milestone	Milestone criteria
		(a) NCPP TSF: 1m minimum thickness layer of weathered Permian and/or Tertiary spoil followed by 2m minimum thickness of more permeable material. (b) Ramp 72 TSF: 1.5m thickness of gravelly spoil or coarse rejects over exposed tailings. Spoil, 3.5m thick at the top of the ramp, 5m thick over coarse rejects over the remainder of the TSF, dumped and spread in such a way that dispersive spoil with high fines content is not placed in the outer 1m of the landform. (c) Laleham TSF, Bottom TSFs and R36 Rejects Dump: 5m thickness of spoil dumped and spread in such a way that dispersive spoil with high fines content is not placed in the outer 1m of the landform. **3.11** The final cover surface of TSFs and reject dumps are water shedding and free from surface ponding, unless an AQP certified alternative design is adopted as described in **RM3.10** **3.12** The flood protection landforms for the residual voids listed in **PRCP15(b)** must be designed to: (a) Prevent inundation during a 0.1% AEP flood event, or a less likely event than a 0.1% AEP event if required per **PRCP16(b)(ii)**; and (b) Mitigate the impacts of high-energy flow (≥2.5m/s) against the constructed landforms, using techniques such as, but are not limited to, energy dissipation measures (e.g. rock lining) and consideration of surface roughness to increase erosional resistance of the landform surface and ensure stability of the landforms. **Additional criteria for historical underground areas:** **3.13** An AQP certified risk assessment is conducted to determine appropriate rehabilitation treatments with consideration for erosional stability of the insitu soil types, safety risks relevant to the proposed PMLU, impacts to either existing rehabilitation areas or otherwise the terrestrial ecological values, and potential ecological impacts or erosional stability considerations from any disturbance caused from the future rehabilitation activities.

Milestone reference	Rehabilitation milestone	Milestone criteria
		3.14 All historical underground areas rehabilitated (e.g. backfilled, plugged / sealed stabilised, access restricted and signposted, etc, where applicable) in accordance with design specifications and methodologies prepared and certified by an AQP. The rehabilitation design must be developed having regard to the findings of the risk assessment required under **RM3.13**. In determining appropriate rehabilitation treatments, the AQP must consider erosional stability, surface safety risks, impacts to existing rehabilitation, ecological values and potential ecological impacts from any disturbance to be caused from the future rehabilitation activities. **3.15** Independent AQP certifies achievement of **RM3.1** to **RM3.14** inclusive.
RM4	Surface preparation	**4.1** **Growth media assessment:** Growth media health and suitability is assessed and documented by an AQP as suitable for the PMLU and target vegetation establishment no more than 6 months prior to placement on the landform for the parameters in **Attachment 1 – Growth Media Quality Criteria**. **4.2** **Amelioration:** Where growth media tested under the criteria of **RM4.1** does not meet the criteria of **Attachment 1 – Growth Media Quality Criteria**, the growth media is ameliorated to achieve the criteria. **4.3** **Growth media placement:** For areas where topsoil has previously been removed, topsoil and or growth media is placed to a depth of: (a) ≥150mm for the cattle grazing and watercourse PMLUs; and (b) ≥100mm for the woodland habitat PMLU. **4.4** **Soil ripping:** Rip on contour at a depth ≥300mm or as recommended by an AQP. **4.5** Independent AQP certifies achievement of **RM4.1** to **RM4.4** inclusive.
RM5	Revegetation	**Cattle Grazing PMLU:** **5.1** Seeding is completed in accordance with the recommended pasture mix and seeding rates provided in **Attachment 2 – Seed Mix Species Lists and Seeding Rates (Table 1.1)**. **5.2** At least 4 species of 3P (preferred, palatable and perennial) grasses, including at least 2 native species of grasses, 2 native shade tree species, and 2 legume species are to be included in the seed mix, as listed in **Attachment 2 – Seed Mix Species Lists and Seeding Rates (Table 1.1 and Table 1.2),** or as recommended by an AQP.

Milestone reference	Rehabilitation milestone	Milestone criteria
		5.3 Shade tree species identified in **Attachment 2 – Seed Mix Species Lists and Seeding Rates (Table 1.2)** are excluded from the seed mixes applied to the upper surfaces of the NCPP TSF, Laleham TSF, Bottom Dam TSF and R36 Rejects Dump. **5.4** Minimum seeding rates of at least 12kg/ha of pure live grass seed, 0.5kg/ha shade tree seed and 3kg/ha of pure live uncoated legume seed are to be applied, unless adjusted by an AQP. **5.5** All seed mixes to include 5kg/ha of Japanese millet (*Echinochloa esculenta*) or similar as a cover crop to protect soils from erosion, unless adjusted by an AQP. **Woodland Habitat PMLU:** **5.6** Target Regional Ecosystems species seed mix for woodland habitat rehabilitation determined and documented by an AQP with consideration of the landform spoil and growth media characteristics, and the commercial availability of seed species. **5.7** Seeding is completed in accordance with the recommended woodland mix and seeding rates provided in **Attachment 2 – Seed Mix Species List and Seeding Rates (Table 2)**. **5.8** At least 6 species from the revegetation lists for framework trees, woody understorey (shrub) species, and grass species are to be included in the seed mix, or as recommended by an AQP as per **RM5.6**. **5.9** Minimum seeding rates of at least 4.5kg/ha of pure live seed for tree species, 3kg/ha of pure live seed for woody understorey species and 10kg/ha of pure live seed for grass species are to be applied, unless adjusted by an AQP as per **RM5.6**. **5.10** All seed mixes will also include 5kg/ha of Japanese millet (*Echinochloa esculenta*) or similar as a cover crop to protect soils from erosion, unless adjusted by an AQP. **Watercourse PMLU:** **5.11** Seeding is completed in accordance with the watercourse species mix and seeding rates provided in **Attachment 2 – Seed Mix Species List and Seeding Rates (Tables 3 and 4)**.

Milestone reference	Rehabilitation milestone	Milestone criteria
		5.12 Minimum seeding rates for upper and mid banks of at least 6kg/ha pure live seed for tree species, 4kg/ha of pure live seed for woody understorey species and 10kg/ha of pure live seed for grass species and other ground species are to be included in the seed mix, unless adjusted by an AQP. **5.13** Minimum seeding rates for lower banks of at least 5kg/ha pure live seed for tree species, 10kg/ha of pure live seed for grass species and other ground species are to be included in the seed mix, unless adjusted by an AQP. **5.14** All seed mixes will also include5 kg/ha of Japanese millet (*Echinochloa esculenta*) or similar as a cover crop to protect soils from erosion, unless adjusted by an AQP. **5.15** Independent AQP certifies achievement of **RM5.1** to **RM5.14** inclusive.
RM6	Achievement of surface requirements	**For all PMLUs**: **6.1** Weeds comprise <5% of total vegetative groundcover, except *Parthenium hysterophorus,* which must not exceed 10%, and must be assessed by an AQP as appropriately managed. **6.2** With respect to erosion: (a) There is no evidence of 'moderate' or 'severe' erosion as defined by **Attachment 3: Erosion Classification Framework**. (b) Any erosion present will not compromise the achievement of a PMLU to a stable condition; and (c) Erosion requiring intervention has been remediated and does not impact achieving the PMLU. **6.3** The following minimum groundcover is achieved for relevant structures (a) Slopes ≤15% constructed with a heavy clay growth media must achieve ≥70% groundcover. (b) Slopes ≤15% constructed with a light clay growth media must achieve ≥50% groundcover (c) Slopes >15 and ≤30% constructed with fresh Permian growth media must achieve ≥80% groundcover.

Milestone reference	Rehabilitation milestone	Milestone criteria
		6.4 Alternative slope grades and groundcover percentage combinations are acceptable where prescribed by an AQP, or the maximum slope grade and length combinations as per **Attachment 10 – Acceptable Material, Slope Grade, Slope Length and Groundcover Combinations for Relevant Structures** are achieved. **Additional criteria for Cattle Grazing PMLU:** **6.5** The groundcover required by **RM6.3** is vegetative groundcover with at least 50% of vegetative dry matter being comprised of pasture species as listed in **Attachment 2 – Seed Mix Species List and Seeding Rates (Table 1)**. **Additional criteria for Woodland Habitat and Watercourse PMLUs:** **6.6** A BioCondition assessment is completed by an AQP using the methodology outlined in the latest version of the Queensland Herbarium's 'BioCondition Assessment Manual'. **6.7** Modified BioCondition assessed under **RM6.6** demonstrates achievement of an overall score of: (a) for Woodland habitat PMLU, ≥15 out of a possible 60 for the hybrid regional ecosystem as defined in **Attachment 5 – Modified BioCondition Benchmarks for Woodland and Watercourse Regional Ecosystems**; and (b) for Watercourse PMLU, ≥15 out of a possible 60 for the relevant representative regional ecosystem as defined in **Attachment 5 – Modified BioCondition Benchmarks for Woodland and Watercourse Regional Ecosystems**. **Additional criteria for TSFs:** **6.8** Monitoring data that has been collected as described in the Closure Landform Design Report (**PRCP12**) or as detailed per relevant technical assessments, or rehabilitation monitoring reports indicate that the TSFs are on a trajectory to achieve a stable condition. **6.9** No deep-rooted trees present.

Milestone reference	Rehabilitation milestone	Milestone criteria
		Additional criteria for underground workings / historical subsidence areas: **6.10** An AQP must certify that areas affected by subsidence, overland flow or surface runoff overlying historical underground workings do not pose an unacceptable safety or environmental risk, do not prevent achievement of the final land use, and do not adversely affect landform stability, vegetation condition, ecosystem function or habitat values. Where relevant, ecosystem condition is to be demonstrated using the appropriate BioCondition assessment. Residual ponding, surface depressions, cracking or minor long-term ground movements that do not present such risks are acceptable and do not require remediation. **6.11** Independent AQP certifies achievement of **RM6.1** to **RM6.10** inclusive
RM7	Achievement of post-mining land use to a stable condition	**For all PMLUs**: **7.1** An AQP certified risk assessment is completed and confirms that the safety hazards in rehabilitation areas are not significantly different to surrounding unmined landscapes subject to the same land use. **7.2** Rehabilitation is assessed as geotechnically stable by an AQP with a minimum FOS ≥1.5 achieved at the safety bund, unless an alternative is justified by an AQP. **7.3** Any remaining infrastructure rehabilitated or removed in accordance with **RM1.1**. **7.4** An AQP certifies that the land is erosionally stable and: (a) There is no moderate or severe erosion present (as defined in **Attachment 3: Erosion Classification Framework**); and (b) All other erosion requiring intervention has been remediated and does not impact achieving the PMLU. **7.5** Surface water runoff is collected and monitored from representative areas of rehabilitation when surface flow occurs, and when it is safe to do so. Surface water quality results are compared, for interpretation purposes only, against the interim trigger levels in **Attachment 7 – Interim Surface Water Quality Trigger Levels** to provide an early indication of rehabilitation performance.

Milestone reference	Rehabilitation milestone	Milestone criteria
		7.6 Surface water in the receiving environment, downstream of completed rehabilitation areas, must be monitored monthly during flow and when it is safe to do so, at the locations specified in **Attachment 6 – Surface Water Monitoring Locations.** Monitoring in the receiving environment must commence no later than one year prior to the completion of **RM7** and must be compared, for interpretation purposes only, with the interim trigger levels in **Attachment 7 – Interim Surface Water Quality Trigger Levels.** An AQP must determine the receiving environment locations that are representative of upstream completed rehabilitation areas. **7.7** Groundwater quality, hydraulically downgradient of completed rehabilitation areas, must be monitored quarterly, at the locations specified in **Attachment 8 – Interim Groundwater Monitoring Locations.** Monitoring must commence no later than one year prior to the completion of **RM7**. Groundwater monitoring results are compared, for interpretation purposes only, against the interim trigger levels in **Attachment 9 Interim Groundwater Quality Trigger Levels**. An AQP must determine the downgradient monitoring locations that are representative of groundwater flow paths from completed rehabilitation areas. **Additional criteria for areas affected by residual ponding in subsidence areas (RA5):** **7.8** Areas of residual ponding score ≥15 out of a possible score of 30 as demonstrated using the relevant BioCondition score for RE11.3.27c as defined in **Attachment 5 – Modified BioCondition Benchmarks for Woodland and Watercourse Regional Ecosystems**. **Additional criteria for Existing Rehabilitation – Cattle Grazing PMLU (RA7):** **7.9** At least 60% of vegetative dry matter yield is comprised of 3P pasture species (Stocktake, 2021). **7.10** Grazing land condition is assessed as Good (A) condition if ungrazed, or Fair (B) if under a grazing regime as per **Attachment 4 – ABCD Land Condition Framework** (DES 2022a). **7.11** Leucaena >2m high: stem density is <250 stems per hectare (1 per 40m^2) mean total area **Additional criteria for Future Rehabilitation – Cattle Grazing PMLU (RA2, RA4):** **7.12** At least 60% of vegetative dry matter yield is comprised of 3P pasture species (Stocktake, 2021).

Milestone reference	Rehabilitation milestone	Milestone criteria
		7.13 Land suitability class is assessed in accordance with 'Rehabilitated mined land suitability for cattle grazing in the Bowen Basin (Short 2023).' Land suitability assessed by an AQP as ≤3; or if ≥4, is not different from pre-mining and/or limited by the same factors present in representative reference sites. **7.14** Leucaena >2m high: stem density is <250 stems per hectare (1 per 40m^2) mean total area. **Additional criteria for Existing Rehabilitation – Woodland Habitat PMLU (RA6):** **7.15** Species richness: ≥2 native tree species; ≥3 native shrub species; ≥4* native grass species **7.16** Tree canopy cover: ≥16% **Existing rehabilitation may contain a mixture of native and exotic grass species* **Additional criteria for Future Rehabilitation – Woodland Habitat PMLU (RA1, RA5):** **7.17** A modified BioCondition assessment is completed by an AQP using the methodology outlined in the latest version of the Queensland Herbarium's 'BioCondition Assessment Manual'. **7.18** Modified BioCondition assessed under **RM7.18** demonstrates achievement of an overall score of ≥33 out of a possible 60 for the relevant representative regional ecosystem as defined in **Attachment 5 – Modified BioCondition Benchmarks for Woodland and Watercourse Regional Ecosystems.** **Additional criteria for Watercourse PMLU (RA3):** **7.19** Index of Diversion Condition (IDC) assessment confirms: (a) Riparian vegetation index is greater or equal to upstream or downstream values (b) Geomorphic index is greater or equal to upstream or downstream values **7.20** A modified BioCondition assessment is completed by an AQP using the methodology outlined in the latest version of the Queensland Herbarium's 'BioCondition Assessment Manual'.

Milestone reference	Rehabilitation milestone	Milestone criteria
		7.21 Modified BioCondition assessed under **RM7.21** demonstrates achievement of an overall score of ≥30 out of a possible 60 for the relevant representative regional ecosystem as defined in **Attachment 5 – Modified BioCondition Benchmarks for Woodland and Watercourse Regional Ecosystems**. **7.22** Assessment report completed by an AQP confirms that diversions are in a stable condition and suitable for relinquishment. **7.23** Independent AQP certifies achievement of **RM1.1** to **RM7.22** inclusive.
RM8	Achievement of post-mining land use water quality	**Surface Water:** **8.1** Surface water quality is monitored monthly during flow at, but not limited to, the monitoring locations specified in **Attachment 6: Surface Water Monitoring Locations**, for all quality characteristics listed in **Attachment 7 – Interim Surface Water Quality Trigger Levels,** for a minimum of 5 consecutive years period immediately prior to surrender. **8.2** With respect to surface water and subject to **RM8.1** the following must be demonstrated prior to surrender: (a) Surface water quality at downstream locations must not exceed the interim trigger values specified in **Attachment 7 – Interim Surface Water Quality Trigger Levels** for 3 consecutive results within the 5-year period immediately prior to surrender; (b) If the surface water quality exceeds criteria (a), the applicable upstream site must be compared to the downstream site result; and the quality result measured at a downstream site must be equal to or less than the quality result measured at the applicable upstream site[2]. **8.3** If the **surface** water quality results monitored per **RM8.2** exceed the criteria listed, an AQP must complete and provide to the administering authority within **3 months** of receiving the relevant sampling results an assessment of the cause of the exceedance and risk of rehabilitation not achieving a stable condition within the schedule timeframe. Where the assessment concludes: (a) that there is a low risk to achieving a stable condition, then no further action is to be taken;

[2] For pH, the quality result measured at the downstream location must be within the prescribed range. However, where pH at the downstream location is greater-than (>) the highest trigger level in the range, the pH at the applicable upstream location must be greater-than or equal-to (≥) the downstream location. Conversely, where pH at the downstream location is less than (<) the lowest trigger level in the range, the upstream pH at the applicable upstream location must be less-than or equal-to (≤) the downstream location.

Milestone reference	Rehabilitation milestone	Milestone criteria
		(b) that there is a risk greater than low to achieving a stable condition, then an assessment of potential environmental harm and any changes or rectification actions to rehabilitation activities must be determined and implemented. **8.4** If **RM8.3** is triggered more than 3 times over 5 consecutive years prior to surrender, the 5-year timeframe as per **RM8.2** is restarted, unless a third-party AQP report determines that: (a) the exceedance is not the result of mining activities; or (b) there remains a low risk to achieving a stable condition. **Groundwater:** **8.5** Groundwater quality is monitored quarterly for at least 5 consecutive years at, but not limited to, the monitoring locations specified in **Attachment 8– Interim Groundwater Monitoring Locations**, for all quality characteristics listed in **Attachment 9 – Groundwater Quality Trigger Levels**. **8.6** The interim trigger levels in **Attachment 9 – Interim Groundwater Quality Trigger Levels** must not be exceeded, for 3 consecutive sampling events within the 5-year period immediately prior to surrender. **8.7** If the groundwater quality results monitored per **RM8.5** exceed the interim trigger levels listed in **Attachment 9 – Interim Groundwater Quality Trigger Levels,** an AQP must complete and provide to the administering authority an assessment of the cause of the exceedance **within 30 business days** of receiving the relevant sampling results. Where the assessment concludes: (a) that the cause of the exceedance is not mining activities or there is a low risk to achieving a stable condition then no further action is to be taken and the exceedance is not counted for the purposes of **RM8.6**; (b) that the cause of the exceedance is mining activities, then an assessment of potential environmental harm and any changes or rectification actions to rehabilitation activities must be determined and implemented; **8.8** Groundwater level is monitored twice per year and for a minimum of 5 consecutive years. **8.9** Independent AQP certifies achievement of **RM8.1** to **RM8.8** inclusive.

Section F – Non-use management areas

(IA1) Improvement area 1

Improvement Areas													
Improvement area	IA1												
Relevant activities	Voids (Ramp 8, Mimosa/Besgrove, Ramp 30, Deep Creek, Stewarton North, Stewarton South, Tannyfoil, South Ballamoo, Kenmare, Togara/North Marshmead, South Marshmead, Comet Downs East, Kennedy West)												
Total size (ha)	3,149												
Commencement of first milestone: MM1	01-Jul-2040												
NUMA	Non-use management area												
Date area is available	1/07/2040	1/07/2045	1/07/2050	1/07/2055	1/07/2060	1/07/2065	1/07/2070	1/07/2075	1/07/2080	1/07/2085	1/07/2090	1/07/2095	
Cumulative area available (ha)	584	584	584	1,673	1,673	1,673	1,758	1,758	1,807	2,157	2,791	3,149	
Milestone completed by	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090	10/12/2095	10/12/2100	10/12/2105
Milestone Reference	**Cumulative area achieved (ha)**												
MM1	584	584	584	1,673	1,673	1,673	1,758	1,758	1,807	2,157	2,791	3,149	
MM3	584	584	584	1,673	1,673	1,673	1,758	1,758	1,807	2,157	2,791	3,149	
MM4		584	584	584	1,673	1,673	1,673	1,758	1,758	1,807	2,157	2,791	3,149

(IA2) Improvement area 2

Improvement Areas						
Improvement area	IA2					
Relevant activities	Voids and TSFs with cover system (Ramp 74 TSF and Bonnie Doon TSF)					
Total size (ha)	164					
Commencement of first milestone: MM1	01-Jul-2040					
NUMA	Non-use management area					
Date area is available	1/07/2040	1/07/2045	1/07/2050			
Cumulative area available (ha)	105	105	164			
Milestone completed by	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070
Milestone Reference	**Cumulative area achieved (ha)**					
MM1	105	105	164			
MM2			105	105	164	
MM3			105	105	164	
MM4				105	105	164

Improvement area milestones

Milestone reference	Management milestone	Milestone criteria
MM1	Achievement of structural stability	**1.1** The maximum area of each NUMA must not exceed the following: (a) Ramp 8 – 26 ha (b) Boonie Doon – 105 ha (c) Mimosa / Besgrove – 701 ha (d) Ramp 30 – 65 ha (e) Deep Creek – 79 ha (f) Stewarton North – 309 ha (g) Stewarton South – 93 ha (h) Tannyfoil – 400 ha (i) South Ballamoo – 350 ha (j) Kenmare – 85 ha (k) Ramp 74 – 59 ha (l) Togara / North Marshmead – 511 ha (m) South Marshmead– 123 ha (n) Kennedy West – 358 ha (o) Comet Downs East – 49 ha **1.2** Pit wall landforms must: (a) Be geotechnically stable when floodwater is against the creek-side batter (b) Not be constructed with dispersive material

		1.3 The closure landform design reports (required by **PRCP12**) must be completed by an AQP based on the latest flood modelling and materials data prior to construction. **1.4** The pit walls and TSFs achieve a minimum FOS ≥1.5 at the safety bund, as certified by an AQP. **1.5** A minimum distance of 50m is to be designed between the residual void crest and the toe of the safety bund, where against an external perimeter mining lease boundary. **1.6** The location of the voids and associated safety bunds does not cause instability or degradation to the land outside the NUMA. **1.7** Residual voids must not overtop to the receiving environment.
MM2	Installation of cover system	**2.1** Cover systems (water / spoil) have been designed, and installed as per engineered design plans as certified by an AQP to achieve the following criteria: (a) Minimum 2m cover thickness, where using spoil; and (b) Minimum 1m depth permanent water cover, where tailings not covered by spoil. **2.2** An AQP has certified that the cover system is built / installed as designed and has completed an 'As Constructed' engineering report for each cover system. **2.3** An AQP demonstrates with modelling that the cover system remains in place post-closure.
MM3	Achievement of safety requirements	**3.1** Access to residual voids is restricted by a competent safety bund or equivalent landform to prevent access, and are constructed to the following specifications: (a) Constructed from competent non-weathered, non-dispersive material; (b) Minimum height of 2m; (c) Minimum base width of 4m; (d) 1 in 3 batters; and. (e) Positioned at the geotechnical offset or a 15m offset, whichever is greater. **3.2** Access to highwalls is restricted by fencing and safety signage designed and installed in accordance with Australian standards current at the time of installation.

MM4	Achievement of sufficient improvement	**4.1** The final landform has been constructed in accordance with the landform closure design report. **4.2** The NUMA will not present an unacceptable risk of environmental harm. **4.3** Erosion of the landform within the NUMA area will not negatively impact on the stability of any adjacent rehabilitation areas, or their ability to sustain their PMLU. **4.4** The NUMA is safe to humans and livestock. **4.5** The water level and quality in the final voids does not, and will, not cause environmental harm to the receiving environment, as demonstrated by groundwater level, surface water and groundwater quality monitoring and modelling. **4.6** An AQP demonstrates with water quality, water level and modelling data, that the residual voids (treated as a system), act as groundwater sinks post-closure and will not cause environmental harm through the release of contaminants from the void lakes beyond the tenure boundaries post-closure. **4.7** NUMAs retain flood immunity for 0.1% AEP events, and during a less likely flood event than an 0.1% AEP event for the R74 residual void if required per **PRCP16(b)(ii)**, as confirmed by flood modelling updated based on that undertaken in accordance with **PRCP17**. **4.8** Independent AQP certifies achievement of **MM1.1** to **MM4.7** inclusive.

Section G – Attachments

Attachment 1 – Growth Media Quality Criteria

Parameter	Criteria		
	Cattle Grazing PMLU (RA2, RA4)	Woodland Habitat PMLU (RA1, RA5)	Watercourse PMLU (RA3)
Available Phosphorus (Colwell P)	≥14mg/kg	≥8mg/kg	≥8mg/kg
Electrical Conductivity Saturation Extract (ECse)	<4dS/m	<4dS/m	<2dS/m
Exchangeable Sodium Percentage (ESP)	≤6%	≤10%	≤6%
pH	6 – 8.4	5.1 – 8.8 or as determined by an AQP	6.0 – 8.8 or as determined by an AQP

Attachment 2 – Seed Mix Species Lists and Seeding Rates

Table 1.1 – Recommended species list and seeding rates for Cattle Grazing PMLU

Scientific name	Common name	Cracking clays and heavy loams/clays	Light loams/sands	Pure live seed[1] (PLS) rate (kg/ha)
Astrebla lappulacea, A, squarrosa, A. elymoides	Mitchell Grasses (curly, bull and hoop)	X	-	1-3 (per species)
Bothriochloa bladhii	Forest Blue Grass	-	X	1-3
*Bothriochloa insculpta cvv. Bisset**	Bisset Creeping Blue Grass	X	X	1-2
*Chloris gayana cvv. Callide**	Callide Rhodes Grass	X	X	1-2
*Chloris gayana cvv. Katambora**	Katambora Rhodes Grass	X	X	1-3
Dichanthium sericeum subsp. sericeum	Queensland Blue Grass	X	-	1-3
Digitaria brownii	Cotton Panic	X	X	1-3
Heteropogon contortus	Black Spear Grass	X	X	1-3
*Megathyrsus maximus var. pubiglumis**	Green Panic	-	X	1-2
*Panicum coloratum var. makarikariense**	Bambatsi Panic	X	-	1-2
Panicum decompositum	Native Millet	X	X	1-3
Urochloa mosambicensis	Sabi Grass	-	X	1-2
Grass species – Total seed weight coated (kg/ha)				**12**
*Stylosanthes seabrana**	Caatinga stylo	X	-	1
*Macroptilium bracteatum **	Burgundy bean	X	X	1-2
*Stylosanthes hamata**	Caribbean stylo	-	X	1
Rhynchosia minima	Rhynchosia	X	X	1-2
Legume species – Total seed weight uncoated (kg/ha)				**3**
Echinochloa esculenta	Japanese Millet	X	X	5

[1] Where pure live seed (PLS) information is not yet available minimum seeding rates should be 16kg/ha uncoated pasture grasses, 4kg/ha uncoated legume species and 5kg/ha cover crop

** Denotes exotic species*

Table 1.2 – Recommended shade tree species list for cattle grazing PMLU

Scientific name	Common name
Blakella citriodora subsp. citriodora	Lemon scented gum
Corymbia clarksoniana	Clarkson's bloodwood
Blakella dallachiana	Dallachy's gum
Eucalyptus crebra	Narrow leaved ironbark
Eucalyptus melanophloia	Silver leafed ironbark
Eucalyptus populnea	Poplar box

Table 2 Recommended species list and seeding rates for Woodland Habitat PMLU

Scientific name	Common name	Commercial availability rating[1]	Life form and functional group code[2]	Cracking Clay and heavy loam/ clay topsoil	Light loams/ sand	Pure live seed[3] rate (kg/ha- uncoated weight)	RE11.5.3	RE11.5.9	RE11.7.1	RE11.7.2	RE11.7.6	RE11.10.7
Acacia catenulata	Bendee	L	LLA	X	X	0.5 -1.5	-	-	X	X****	-	-
Acacia harpophylla	Brigalow	L	LLA	X	X	0.5 -1.5	-	-	X	-	-	-
Acacia rhodoxylon	Rosewood	L	LLA	X	X	0.5 -1.5	X	X	X	X****	X	-
Acacia shirleyi	Lancewood	L	LLA	X	X	0.5 -1.5	-	X	X	X****	X	-
Alphitonia excelsa	Red ash	H	NE/NA	X	X	0.2-0.5	X	X	X	X	X	X
Angophora leiocarpa	Smooth barked apple	L	E/C	-	X	0.2-0.5	X	-	-	X	X	X
Atalaya hemiglauca	Whitewood	H	NE/NA	X	X	0.2-0.5	X	-	-	X	X	X
*Blakella citriodora subsp. citriodora**	Lemon scented gum	H	E/C	X	X	0.5 -1.5	-	-	-	X*	X*	-
Corymbia clarksoniana	Clarkson's bloodwood	M	E/C	X	X	0.5-1	X	X	-	X	-	X
Blakella dallachiana	Dallachy's gum	M	E/C	X	X	0.2-0.5	X	X	-	X	-	X
Corymbia erythrophloia	Red bloodwood	H	E/C	X	X	0.2-0.5	X	-	-	X	-	X
Corymbia leichhardtii	Yellow jacket	M	E/C	X	X	0.2-0.5	-	-	-	X	X	-
Corymbia trachyphloia	Brown bloodwood	M	E/C	X	X	0.2-0.5	-	-	-	X	X	-
Blakella tessellaris	Moreton Bay ash	L	E/C	X	X	0.2-0.5	-	-	-	X	-	-
Eucalyptus cambageana	Dawson's gum	H	E/C	X	X	0.2-0.5	-	-	-	X	-	-
Eucalyptus crebra	Narrow leafed ironbark	H	E/C	X	X	0.5 -1.5	X	X*	-	X*	X*	X*
Eucalyptus decorticans	Gum-topped ironbark	L	E/C	-	-	0.1-0.5	-	-	-	X	X	-
Eucalyptus fibrosa subsp. fibrosa	Red Ironbark	M	E/C	X	X	0.1 -1.5	-	-	-	-	X	-
Eucalyptus exserta	Queensland peppermint	H	E/C	-	X	0.3-0.5	-	X	-	X	-	-
Eucalyptus melanophloia	Silver leafed ironbark	H	E/C	X	X	0.5 -1.5	X*	-	-	-	-	X
Eucalyptus thozetiana	Thozet's gum	L	E/C	-	-	0.3-0.5	-	-	X*	X	-	-
Eucalyptus moluccana	Gum topped box	M	E/C	X	X	0.5 -1.5		-	-	-	X	-
Eucalyptus populnea	Poplar box	M	E/C	X	X	0.5 -1.5	X*	-	-	X	X	X
Lysiphyllum carronii	Red bauhinia	M	NE/NA	X	X	0.2-0.5	X	-	-	-		-
Lysiphyllum hookeri	White bauhinia	M	NE/NA	X	-	0.2-0.5	X	-	-	-		-
Ventilago viminalis	Vine tree	M	NE/NA	X	-	0.2-0.5	X		-	--	X	-
Framework tree species – Total seed weight uncoated (kg/ha)						**4.5**						
Acacia conferta	Crowded-leaf wattle	H	SU	-	X	0.2-0.5	X	X	-	-	X	-
Acacia crassa	Curracabah	L	ILA	X	X	0.2-0.5	-	-	X	X	X	-
Acacia excelsa	Ironwood wattle	L	ILA	X	X	0.2-0.5	X	X	-	-	X	X
Acacia leptostachya	Townsville Wattle	M	SU	-	X	0.2-0.5	-	X	-	-	-	-
Acacia sericophylla	Desert oak	M	ILA	-	X	0.2-0.5	X	-	-	-	-	-
Alectryon diversifolius	Native holly	L	SU	X	X	0.2-0.5	X	-	X	X	X	-
Alstonia constricta	Bitterbark	L	SU	X	X	0.2-0.5		X	-	X		-
Breynia oblongifolia	Coffee bush	L	SU	X	X	0.2-0.5		X	-	X	X	X
Capparis lasiantha, C. canescens, C. loranthifolia.	Wait-a-while	M	V/C	X	X	0.2-0.5	X	X	X	X	X	-
*Cassia brewsteri**	Leichhardt bean	H	SU	X	X	0.3-0.5	X	-	X	-	X	-
Croton insularis	Silver croton	L	SU	-	X	0.2-0.5	-	-	X	X	X	-
Dodonaea triangularis	Triangle hop bush	L	SU	X	X	0.1-0.5	-	-	X	X	X	-
Dodonaea oxyptera	Hop bush	L	SU	X	X	0.1-0.5	-	-	X	X	X	-
*Dodonaea viscosa**	Sticky hop bush	H	SU	X	X	0.2-0.5	X	-	X	-	X	-
Dodonaea filifolia	Thread leaved hop bush	L	SU	X	X	0.1-0.5	-	-	-	X	X	-
Denhamia cunninghamii		L	SU	X	X	0.1– 0.5	X	-	-	-	X	-
Eremophila mitchellii	False sandlewood	L	SU	X	X	0.1-0.5	X	-	X	X	-	X
Erythroxylon australe	Cocaine tree	L	SU	X	X	0.1-0.5	X	X	X	X	-	X
Geijera parvifolia	Wilga	H	SU	X	X	0.1-0.5	X	X	X	X	X	X
Grewia latifolia	Dogs balls	H	SU	X	X	0.2-0.5	X	X		-	X	X

Scientific name	Common name	Commercial availability rating[1]	Life form and functional group code[2]	Cracking Clay and heavy loam/ clay topsoil	Light loams/ sand	Pure live seed[3] rate (kg/ha- uncoated weight)	RE11.5.3	RE11.5.9	RE11.7.1	RE11.7.2	RE11.7.6	RE11.10.7
Myoporum montanum, M. acuminatum	Boobialla	H	SU	X	X	0.1-0.5	X	X	X	X	X	-
Philotheca difformis	Small-Leaf Wax-Flower	L	SU	X	X	0.1-0.5	-	-	X	X	X	-
Persoonia falcata	Wild pear	L	SU	X	X	0.1-0.3	X	X	X	X	X	-
Petalostigma pubescens	Quinine	M	SU	X	X	0.3-0.5	X	X	-	X	-	-
Senna artemisioides	Silver cassia	H	SU	X	X	0.3-0.5	X	-	-	-	X	-
Woody understory species – Total seed weight uncoated (kg/ha)						**3**						
Astrebla lappacea	Curly Mitchell grass	H	NG	X	-	1-2	X**	X**	-	-	-	-
Aristida spp (i.e. A. calycina, A. benthamii, A. latifolia, A. ramosa, A. caput-medusae, A. jerichoensis, A. personata, A. calycina)	Three awned spear grass	M	NG	-	X	1-2	X	X	X	X	X	X
Bothriochloa bladhii subsp. bladhii	Forest blue grass	H	NG	X	X	1-2	X	X	-	X**	-	-
Bothriochloa decipiens var. decipiens	Pitted blue grass	L	NG	X	X	0.5-1	X	-	--	X**	X	X
Bothriochloa ewartiana	Desert bluegrass	L	NG	X	X	0.5-1	X	-	-	-	-	-
Calyptochloa gracillima		L	NG	X	X	0.5-1	-	X	X	X	X	-
Chloris divaricata	Slender Chloris	M	NG	X	X	0.5-1	-	-	X	-	-	-
Chloris truncata	Windmill grass	H	NG	X	X	2-4	X***	X***	X***	X***	X***	X***
Chloris ventricosa	Tall Chloris	M	NG	X		1-2	-	-	X		X	X
Chrysopogon fallax	Golden beard grass	L	NG	X	X	0.5-1	X	X	X	X	X	X
Cymbopogon refractus, C. bombycinus	Barbwire grass	H	NG	X	X	0.5-1	X	X	X	X**	X	X
*Cynodon dactylon var. dactylon**	Couch	H	EG	X	X	2	X***	X***	X***	X***	X***	X***
Dichanthium sericeum subsp. sericeum	Queensland bluegrass	H	NG	X	X	1-2	X	-	-	-	-	-
Dinebra decipiens	Slender cane grass	L	NG	X	X	0.5-1	X		X	X	X	-
Enteropogon acicularis	Curly windmill grass	M	NG	X	X	0.5- 2	X	X	X	X	X	-
Eulalia aurea	Silky brown top	M	NG	X	X	0.5-1	X	-	-	X**	-	-
Heteropogon contortus	Black spears	M	NG	X	X	1-2	X	X	X	X**	X	X
Panicum effusum	Hairy panic	L	NG	X	X	0.5-1	X	X	X	X	X	X
Panicum decompositum	Native millet	H	NG	X	-	1-2	X	X	-	X	-	-
Panicum queenslandicum	Yabila grass	L	NG	X	-	0.5-1	X	X	-	-	--	-
Paspalidium distans	Shot grass	M	NG	-	X	0.5-1	-	-	X	X	X	-
Themeda triandra	Kangaroo grass	H	NG	X	X	1-2	X	X	X	X**	X	X
Triodia pungens	Spinifex	L	NG		X	0.5-1	X	-	-	X	X	-
Grass species – Total seed weight uncoated (kg/ha)						**10**						
Echinochloa esculenta	Japanese millet		Cover crop	X	X	5	-	X***	X***	X***	X***	X***

[1] Commercial availability rating: high (H), medium (M), low (L)
[2] Life form and functional group code: Eucalypt/Bloodwood (Corymbia) species (E/C), Non-eucalypt, non-acacia species (NE/NA), Long lived acacias (LLA), Shrubby understorey (SU), Groundcover shrubs (GCS), Vines/creepers (V/C), Intermediate lifespan acacias (ILA), Short lifespan wattles (SLA), Introduced woody perennials (IWP), Competitive pasture grasses (CPG), Introduced grasses (IG), Native grasses (NG)
[3] Where pure live seed (PLS) information is not yet available minimum seeding rates must be at least 6kg/ha uncoated framework tree species, 4kg/ha uncoated woody understory species, 10 kg/ha uncoated grass species and 5kg/ha cover crop
** mandatory in relevant RE mix*
*** medium salinity tolerance (DERM 2011)*
**** additional grass species to support groundcover and stability from other representative REs*
***** RE11.7.2 Requires at least 50% or 1.5kg/ha of any combination of Acacia catenulata, Acacia rhodoxylon* and *Acacia shirleyi.*

Table 3 – Recommended species list and seeding rates for Watercourse PMLU – upper and mid banks

Species name	Common name	Life form and functional group code	Pure Live Seed rate (kg/ha – uncoated weight)
*Acacia stenophylla***	River Myall	LLA	0.5 – 1
Alphitonia excelsa	Red Ash	NE/NA	0.5 – 1
Angophora floribunda	Rough Barked Apple	E/C	0.5 – 1
Angophora leiocarpa	Smooth Barked Apple	E/C	0.5 – 1
Angophora subvelutina	Broadleaf Apple	E/C	0.5 – 1
*Casuarina cristata***	Belah	E/C	0.5 – 1
Casuarina cunninghamiana, **	River She Oak	NE/NA	0.5 – 1
*Corymbia tessellaris***	Moreton Bay Ash	NE/NA	0.5 – 1
*Eucalyptus camaldulensis *, **	River Red Gum	E/C	1 – 2
Eucalyptus coolabah subsp. coolabah	Coolabah	E/C	1 – 2
Eucalyptus melanophloia	Silver Leaved Ironbark	E/C	0.5 – 1
Eucalyptus populnea	Poplar Box	E/C	0.5 – 1
Eucalyptus tereticornis, **	Queensland Blue Gum	E/C	0.5 – 1
Lysiphyllum hookeri	White Bauhinia	NE/NA	0.5 – 1
Melaleuca bracteata, **	Black Tea Tree	NE/NA	0.5 – 1
Terminalia oblongata	Yellowwood	NE/NA	0.5 – 1
Framework tree species – total seed weight uncoated (kg/ha)			**6**
Acacia excelsa	Ironwood Wattle	ILA	0.5 – 1
Acacia fasciculifera	Scaly Bark	ILA	0.5 – 1
*Cassia brewsteri***	Leichardt Bean	SU	0.5 – 1
Dodonaea viscosa	Sticky Hop Bush	SU	0.5 – 1
Eremophila mitchellii	False Sandalwood	SU	0.5 – 1
Erythroxylum australe	Cocaine Tree	SU	0.5 – 1
Ficus coronata	Creek Sandpaper Fig	SU	0.5 – 1
Ficus fraseri	White Sandpaper Fig	SU	0.5 – 1
Ficus opposita	Sandpaper Fig	SU	0.5 – 1
Grevillea striata	Beefwood	SU	0.5 – 1
Grewia latifolia	Dogs Balls	SU	0.5 – 1
Hakea lorea	Bootlace Oak	SU	0.5 – 1
Mallotus philippensis	Red Kamala	SU	0.5 – 1
Petalostigma pubescens	Quinine	SU	0.5 – 1
Woody understorey species – total seed weight uncoated (kg/ha)			**4**
Bothriochloa bladhii	Forest Blue Grass	NG	1 – 2
Cymbopogon refractus	Barbwire Grass	NG	1 – 2
Capillipedium spicigerum	Scented Top	NG	0.2 – 0.5
*Chloris divaricata or C. Ventricosa**	Slender Chloris, Tall Windmill Grass	NG	1 – 2
Cynodon dactylon,***	Couch	IG	2
Dichanthium sericeum subsp. sericeum	Queensland Bluegrass	NG	1 – 2
Digitaria brownii	Cotton Panic	NG	1 – 2
Eulalia aurea	Silky Brown Top	NG	1 – 2
Heteropogon contortus	Bunched Speargrass	NG	1 – 2
Lomandra longifolia	Mat Rush	NG	1 – 2
Panicum effusum	Hairy Panic	NG	1 – 2
Paspalidium distans	Shot Grass	NG	1 – 2
Themeda triandra	Kangaroo Grass	NG	1 – 2
Ground species – total seed uncoated (kg/ha)			**10**
Echinochloa esculenta	Japanese Millet	Cover crop	5

Notes:

[1] Life form and functional group code: Eucalypt/Bloodwood (Corymbia) species (E/C), Non-eucalypt, non-acacia species (NE/NA), Long lived acacias (LLA), Shrubby understorey (SU), Groundcover shrubs (GCS), Vines/creepers (V/C), Intermediate lifespan acacias (ILA), Short lifespan wattles (SLA), Introduced woody perennials (IWP), Competitive pasture grasses (CPG), Introduced grasses (IG), Native grasses (NG)

[2] Where pure live seed (PLS) information is not yet available minimum seeding rates must be at least 6kg/ha uncoated framework tree species, 4kg/ha uncoated woody understory species, 10 kg/ha uncoated grass species and 5kg/ha cover crop

** mandatory in relevant RE mix*

*** medium salinity tolerance (DERM 2011)*

Table 4 – Recommended Species list and seeding rates for Watercourse PMLU – lower banks

Species name	Common name	Life form and functional group code[1]	Pure Live Seed[2] rate (kg/ha – uncoated weight)
Casuarina cunninghamiana, ***	River She Oak	NE/NA	0.5 – 1
Melaleuca bracteata, ***	Black Tea Tree	NE/NA	0.5 – 1
Melaleuca fluviatilis	Weeping Tea-Tree	NE/NA	0.5 – 1
*Melaleuca linariifolia***	Snow In Summer	NE/NA	0.5 – 1
*Melaleuca leucadendra ***	Broad-Leaved Tea Tree	NE/NA	0.5 – 1
Melaleuca viminalis, ***	Red Bottlebrush	NE/NA	0.5 – 1
Melaleuca trichostachya	Flax-Leaf Paperbark	NE/NA	0.5 – 1
Lophostemon suaveolens	Swamp Box	NE/NA	0.5 – 1
Framework tree species – total seed weight uncoated (kg/ha)			**5**
Bothriochloa bladhii subsp. bladhii	Forest Blue Grass	NG	1 – 2
Chloris divaricata or C. ventricosa	Slender Chloris, Tall Windmill Grass	NG	1 – 2
Cymbopogon refractus	Barbwire Grass	NG	1 – 2
Cynodon dactylon, ***	Couch	IG	2 – 3
*Cyperus spp. (C. gracilis, C. fulvus)****	Sedge	NG	2 – 3
Dichanthium sericeum subsp. sericeum	Queensland Bluegrass	NG	1 – 2
*Lomandra longifolia****	Spiny-Headed Mat Rush	NG	2 – 3
Paspalidium distans	Shot Grass	NG	1 – 2
Themeda triandra	Kangaroo Grass	NG	1 – 2
Ground species – total seed weight uncoated (kg/ha)			**10**
Echinochloa esculenta	Japanese Millet	Cover crop	5

Notes:

[1] Life form and functional group code: Eucalypt/Bloodwood (Corymbia) species (E/C), Non-eucalypt, non-acacia species (NE/NA), Long lived acacias (LLA), Shrubby understorey (SU), Groundcover shrubs (GCS), Vines/creepers (V/C), Intermediate lifespan acacias (ILA), Short lifespan wattles (SLA), Introduced woody perennials (IWP), Competitive pasture grasses (CPG), Introduced grasses (IG), Native grasses (NG)

[2] Where pure live seed (PLS) information is not yet available minimum seeding rates must be at least 6kg/ha uncoated framework tree species, 4kg/ha uncoated woody understory species, 10 kg/ha uncoated grass species and 5kg/ha cover crop

** mandatory in relevant RE mix*

*** medium salinity tolerance (DERM 2011)*

**** bank toe area only*

Attachment 3 – Erosion Classification Framework

Erosion classification	Minor[1]	Moderate[1]	Severe[1]
Sheet erosion	Shallow soil deposits downslope.	Active[3] sheet erosion including indicators such as exposure of roots, moderate soil deposits in downslope sediment traps.	Active[3] sheet erosion including loss of surface horizons, exposure of subsoil horizons, pedestalling, root exposure, substantial soil deposits in downslope sediment traps.
Rill[6]	<7 active[3] rills / 50m transect[5]	7-15 active[3] rills / 50m transect[5]	>15 active[3] rills / 50m transect[5]
Gully erosion	Stabilised[4] gullies 30cm – 100cm depth; isolated, linear, discontinuous and restricted to primary or minor drainage lines.	Active[3] gullies 30cm – 100cm depth; isolated, linear, discontinuous and restricted to primary or minor drainage lines.	Active[3] gullies >100cm depth
Tunnel erosion	No tunnel erosion[2]	No tunnel erosion[2]	Tunnel erosion present
Mass movement	No mass movement[2]	No mass movement[2]	Mass movement present

Notes:
[1] State of Erosion form definitions: *NCST (2024) Australian Soil and Land Survey Field Handbook, 4th edition. The National Committee on Soil and Terrain. CSIRO Publishing, Collingwood, Australia.*
[2] No erosion: no evidence of any erosion types.
[3] Active: One or both of the following conditions apply: evidence of sediment movement; sides and/or floors of erosion form are relatively bare of vegetation.
[4] Stabilised: One or both of the following conditions apply: no evidence of sediment movement; sides and/or floors of erosion form are revegetated.
[5] The erosion monitoring transect is established by running a 50m tape at an angle perpendicular to the slope (i.e. along the contour).
[6] Rill frequency assessed over the entire rehabilitation area (not only features that intersect an existing monitoring transect).

Attachment 4 – ABCD Land Condition Framework

ABCD Land Condition Framework	
The ABCD land condition framework (*Grazing Guide version 2, Department of Environment, Innovation and Science, 2022*)	
Good condition (A)	**Fair condition (B)**
Often above 70% groundcover	Minimum 50% groundcover, but often less than 70% groundcover
Good density of perennial grasses (less than 30% bare ground), dominated by 3P grasses ≥80%	Decreased density of perennial grasses (bare ground > 30% but < 50%), dominated by 3P grasses ≥60%
Few weeds, no significant infestations	Increased weeds, no significant infestations
Good soil condition, no erosion	Decline in soil condition, minor erosion only as per **Attachment 3 – Erosion Classification Framework**.

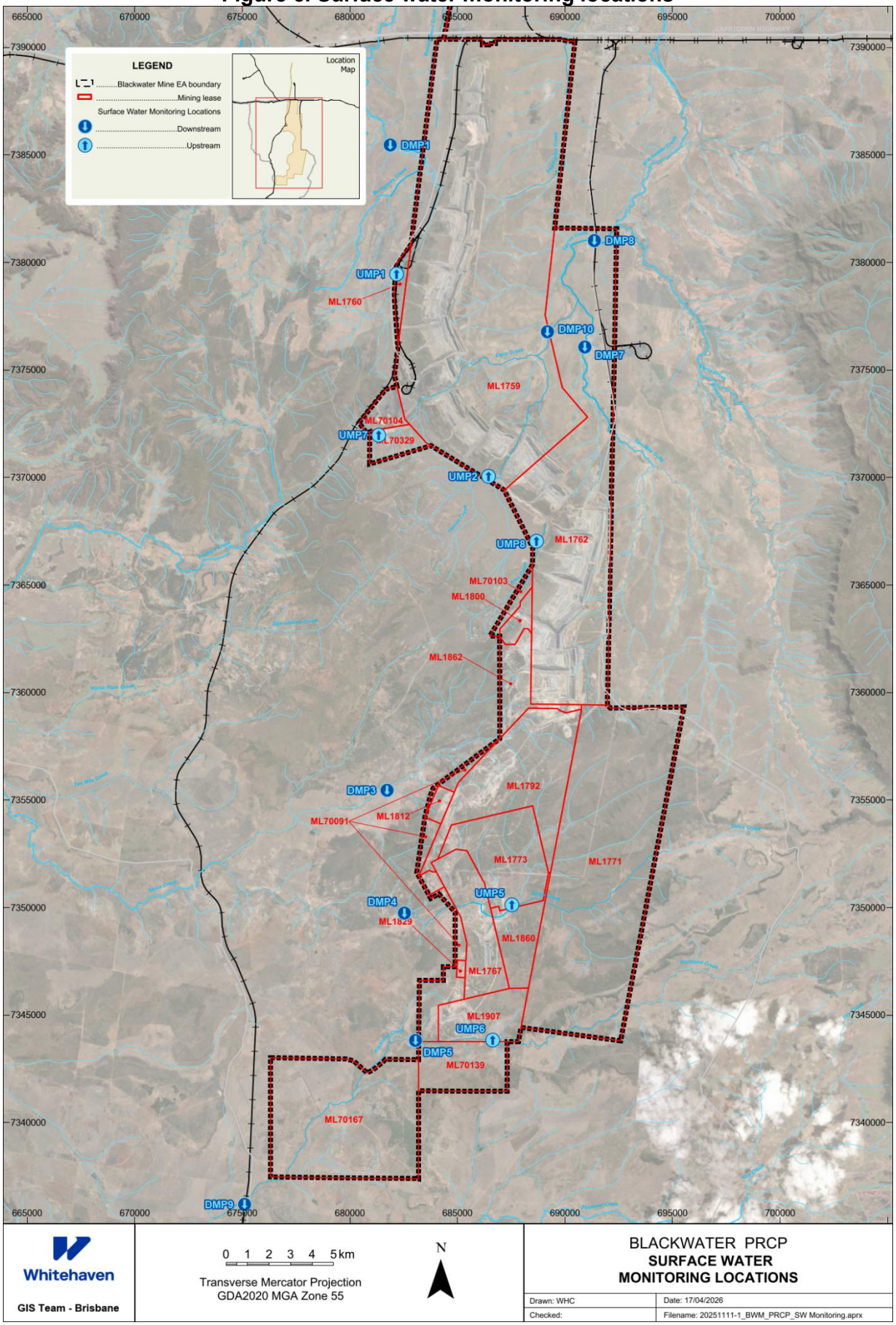
Attachment 5 – Modified BioCondition Benchmarks for Woodland and Watercourse Regional Ecosystems

BioCondition Accessible Attribute	Maximum score for Attributes	RE11.5.3	RE11.5.9	RE11.7.2	RE11.7.6	RE11.7.1	RE11.3.25	RE11.10.7	RE11.3.27 (ponded areas only)
Recruitment of woody perennial species in ecologically dominant layer (%)	5	100	100	100	100	100	100	100	NA
Native plant species richness – trees	5	6	3	3	4	4	4	6	NA
Native plant species richness – shrubs	5	6	6	4	5	8	4	6	NA
Native plant species richness – grasses	5	6	9	5	10	8	8	7	2
Native plant species richness – forbs	5	10	11	5	16	9	13	9	10
Tree canopy height (m)	5	16	17	15	25	20	23	18	NA
Tree canopy cover (%)	5	20	25	40	40	27	34	40	NA
Shrub canopy cover (%)	5	3	10	4	11	10	7	8	NA
Native grass cover (%)	5	19	26	15	23	20	35	20	11
Organic litter (%)	5	20	30	20	52	20	21	53	4
Non-native plant cover (%)	10	0	0	0	0	0	0	0	0
Maximum score	60	≥33	≥33	≥33	≥33	≥33	≥30	≥33	≥30

Attachment 6 – Surface Water Monitoring Locations

Monitoring points	Receiving waters location description	Latitude (GDA2020)	Longitude (GDA2020)
Upstream background monitoring points			
UMP1	Upstream Burngrove Creek, 5km from RP1	-23.685442	148.786577
UMP2	Upstream Taurus Ck 3300m U/S of RP2	-23.76985	148.82968
UMP5	Upstream Sirius Ck 2200m U/S of RP5 & 8	-23.949568	148.842866
UMP6	Upstream Rockland Creek, 3.5km from RP6	-24.006466	148.834899
UMP7	Upstream Deep Ck U/S of RP3	-23.75315	148.77936
UMP8	Upstream Two Mile Gully U/S of RP4	-23.79681	148.85192
Downstream monitoring points			
DMP1	Downstream Burngrove Creek, 2.5km from RP1	-23.631288	148.782969
DMP3	Downstream Speculation Ck	-23.902163	148.785195
DMP4	Downstream Sirius Creek	-23.95363	148.79383
DMP5	Downstream Rockland Creek	-24.007041	148.799663
DMP7	Far Downstream Two Mile Gully	-23.715032	148.872814
DMP8	Downstream Taurus Ck	-23.67032	148.876505
DMP9	Far Downstream Rockland Creek	-24.076739	148.722475
DMP10	Downstream Deep Creek	-23.70886	148.85567

Figure 5. Surface water monitoring locations



Attachment 7 – Interim Surface Water Quality Trigger Levels

Quality characteristics (units)	Unit	Trigger level	Comment on trigger level
pH	pH Units	6.5 – 8.5	WQO
Electrical Conductivity	µS/cm	366 / 275	Site-specific Mackenzie River tributaries / Comet River tributaries – 80th percentile
Turbidity	NTU	400	Site-specific – 80th percentile
Sulphate	mg/L	14 / 6	Site-specific Mackenzie River tributaries / Comet River tributaries – 80th percentile
Ammonia	mg/L	0.15	Site-specific – 80th percentile
Nitrate	mg/L	0.8	Site-specific
Fluoride	mg/L	0.4	Site-specific
Aluminium	µg/L	1,097	Site-specific – 95th percentile
Antimony	µg/L	9	ANZG 2018
Arsenic	µg/L	13	ANZG 2018
Boron	µg/L	100	Site-specific – 95th percentile
Cadmium	µg/L	0.2	ANZG 2018
Iron	µg/L	530	Site-specific – 80th percentile
Manganese	µg/L	412	Site-specific – 95th percentile
Mercury	µg/L	0.06	ANZG 2018
Molybdenum	µg/L	5	Site-specific – 95th percentile
Nickel	µg/L	11	ANZG 2018
Selenium	µg/L	5	ANZG 2018
Uranium	µg/L	0.5	ANZG 2018
Vanadium	µg/L	6	ANZG 2018
Zinc	µg/L	8	ANZG 2018
Total recoverable hydrocarbons (C6-C9)	µg/L	20	
Total recoverable hydrocarbons (C10-C36)	µg/L	100	
Major ions (mg/L) Calcium, chloride, potassium, magnesium, sodium, bicarbonate, carbonate		For interpretation purposes	
Hardness (mg/L)		For interpretation purposes	

Notes:

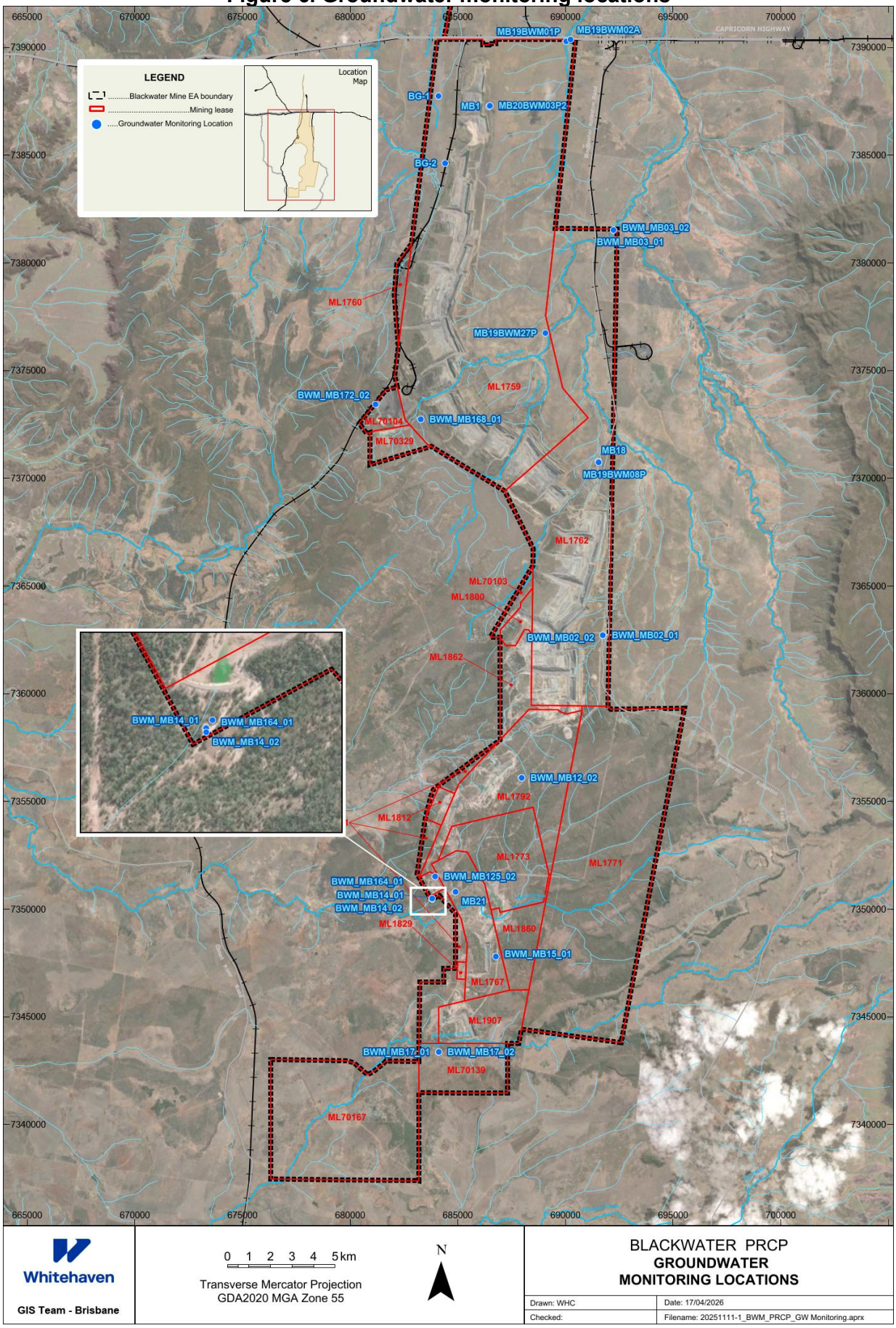
- *All metals and metalloids must be measured as 'dissolved' (from analysis of a field filtered sample) and total (unfiltered).*
- *Interim trigger levels for metals and metalloids apply to dissolved results.*
- *ANZG (2018) Aquatic ecosystem protection for moderately disturbed system (95% protection).*
- *WQO – Mackenzie River southern tributaries and Comet River Eastern tributaries*
- *Assessment of turbidity to consider post-first flush only.*

Attachment 8 – Groundwater Monitoring Locations

Bore Name	Location	Latitude (GDA2020)	Longitude (GDA2020)	Monitored Aquifer
BG-1	MB14 West Bonnie Doon	-23.610428	148.804513	Burngrove Formation
BG-2	SE corner of ML1762, downgradient MB for Blackwater Creek catchment	-23.638561	148.807897	Burngrove Formation
BWM_MB02_01	Central. East, monitor downgradient from existing pits. Co-located with 02_02	-23.835476	148.882626	Permian inter/over burden
BWM_MB02_02	Central. East, monitor downgradient from existing pits. Co-located with 02_01	-23.835468	148.882499	Permian Coal
BWM_MB03_01	North. NE corner ML1762, monitor downgradient from existing pits, Blackwater Ck catchment. Co-located with 03_02	-23.665680	148.884891	Alluvium
BWM_MB03_02	North. NE corner ML1762, monitor downgradient from existing pits. Co-located with 03_01	-23.665626	148.884920	Rewan Formation
BWM_MB12_01	Kenmare UG and adjacent east of Terang Pit Ramp 64/66	-23.895626	148.846277	Tertiary sediments
BWM_MB12_02	Kenmare UG and adjacent east of Terang Pit Ramp 64/66	-23.895670	148.846376	Permian Coal
BWM_MB125_02	Upgradient Red Dam	-23.937460	148.807469	Tertiary sediments
BWM_MB14_01	Red Dams, south of Lower Red Dam wall on inside corner of lease boundary	-23.946911	148.806127	Permian inter/over burden
BWM_MB14_02	Red Dams, south of Lower Red Dams wall on inside corner of lease boundary	-23.947011	148.806129	Permian inter/over burden
BWM_MB15_01	East of Ramp 80	-23.970678	148.835662	Tertiary sediments
BWM_MB164_01	Downgradient Red Dam	-23.946711	148.806292	Tertiary sediments
BWM_MB168_01	Downgradient NCPP TSF	-23.745972	148.798273	Weathered Coal (RCM)
BWM_MB17_01	ML70139 south, south of Marshmead Pit, to be mined out by FY30	-24.011000	148.810088	Basalt

Bore Name	Location	Latitude (GDA2020)	Longitude (GDA2020)	Monitored Aquifer
BWM_MB17_02	ML70139 south, south of Marshmead Pit, to be mined out by FY30	-24.010981	148.810167	Tertiary sediments
BWM_MB172_02	Upgradient NCPP TSF	-23.739944	148.777611	Sandstone (Burngrove)
MB1	East of Bonnie Doon	-23.614502	148.827470	Permian Coal
MB18	East Ramp 46, north of BLW Administration area	-23.762676	148.879409	Permian inter/over burden
MB19BWM01P	Far NE corner of BLW ML1759, near BLW township	-23.586810	148.862287	Permian Coal
MB19BWM02A	Far NE corner of BLW ML1759, near BLW township	-23.586055	148.864266	Permian inter/over burden
MB19BWM08P	East Ramp 46, north of BLW Administration area	-23.763045	148.879552	Permian Coal
MB19BWM27P	North. East, Co-located with 07A, 25P and VWP19BWM01	-23.709180	148.854548	Permian Coal
MB20BWM03P2	Southeast of Bonnie Doon	-23.614244	148.827917	Permian Coal
MB21	South of Duck Pond	-23.943795	148.816910	Tertiary Sediments

Figure 6. Groundwater monitoring locations



Attachment 9 – Interim Groundwater Quality Trigger Levels

Table 1

Quality characteristic	Units	Monitoring Bore*	Limit	Comment
pH (pH units)	pH units	All bores other than MB1, MB21 and MB19BWM02A	6.5 – 8.5	
Electrical Conductivity (EC)	µS/cm	All bores other than bores listed in Table 2	7,410	WQO
Sulphate	mg/L	All bores other than bores listed in Table 2	120	WQO
Nitrate	mg/L	All bores	2.9	WQO
Fluoride	mg/L	All bores	0.4	WQO
Dissolved Aluminium	µg/L	All bores	55	ANZG 2018
Dissolved Antimony	µg/L	All bores	9	ANZG 2018
Dissolved Arsenic	µg/L	All bores	13	ANZG 2018
Dissolved Boron	µg/L	All bores	940	ANZG 2018
Dissolved Cadmium	µg/L	All bores	0.2	ANZG 2018
Dissolved Iron	µg/L	All bores other than bores listed in Table 2	280	ANZG 2018
Dissolved Manganese	µg/L	All bores	540	Site-specific
Dissolved Mercury	µg/L	All bores	0.06	ANZG 2018
Dissolved Molybdenum	µg/L	All bores	5	Site-specific
Dissolved Nickel	µg/L	All bores	11	ANZG 2018
Dissolved Selenium	µg/L	All bores	5	ANZG 2018
Dissolved Uranium	µg/L	All bores	0.5	ANZG 2018
Dissolved Vanadium	µg/L	All bores	6	ANZG 2018
Dissolved Zinc	µg/L	All bores	8	ANZG 2018
Total Recoverable Hydrocarbons (C6-C10)	µg/L	All bores	20	
Total Recoverable Hydrocarbons (>C10-C40)	µg/L	All bores	100	
Major ions – calcium, chloride, potassium, magnesium, sodium, bicarbonate, carbonate	mg/L	All bores	For interpretation purposes	
Hardness	mg/L	All bores	For interpretation purposes	
Water level	mAHD	All bores	For interpretation purposes	

Notes:

- *All metals and metalloids must be measured as 'dissolved' (from analysis of a field filtered sample) and total (unfiltered).*
- *Interim trigger levels for metals and metalloids apply to dissolved results.*
- *ANZG (2018) Aquatic ecosystem protection for moderately disturbed system (95% protection)*
- *WQO – Fitzroy Basin Groundwater Zone 36.*
- **Bore specific interim trigger levels may apply (See Table 2 below)*

Table 2 Site-specific bore interim trigger levels

Quality characteristics	Unit	Trigger Levels									
		MB1	MB18	MB21	MB19BWM02A	MB19BWM01P	MB19BWM08P	MB19BWM27P	MB20BWM03P2	BG-1	BG-2
pH	pH units	6.3 – 7.4	As per Table 1 above.	6.1 – 7.1	6.0 – 8.5	As per Table 1 above.	As per Table 1 above.	As per Table 1 above.	As per Table 1 above.	As per Table 1 above.	As per Table 1 above.
Electrical Conductivity (EC)	µS/cm	39,560	18,590	15,890	37,860	26,430	5,500	15,190	20,180	15,780	18,170
Sulphate	mg/L	415	8	600	515	11	5	0.5	1	140	1,510
Dissolved Iron	µg/L	6,275	2,630	3,875	630	2,125	322	1,885	1,565	190	670

Attachment 10 – Acceptable Material, Slope Grade, Slope Length and Groundcover Combinations for Relevant Structures

Heavy Clay		
Groundcover (%)	**Slope Gradient (%)**	**Maximum Slope Length (m)**
70	>15 – ≤20	340
	>20 – ≤25	200

Light Clay		
Groundcover (%)	**Slope Gradient (%)**	**Maximum Slope Length (m)**
70	>15 – ≤25	750

Fresh Permian		
Groundcover (%)	**Slope Gradient (%)**	**Maximum Slope Length (m)**
60	>15 – ≤20	500
	>20 – ≤25	380
	>25 – ≤30	240

Notes:

- *Acceptable average annual erosion rates: Clays < 5 t/ha/year; Fresh Permian <10 t/ha/year.*
- *Maximum slope lengths derived from WEPP data and as presented in Appendix 4.8a Landform Design (Appendix B).*

END OF PRCP SCHEDULE

Blackwater Mine

PRC Plan Hydrogeology Assessment – Revision 3

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28 September 2026

Revision: 3.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
1.0	8 May 2026	Sharon Hulbert	Ines Epari	Ines Epari
2.0	14 May 2026	Sharon Hulbert	Ines Epari	Ines Epari
3.0	28 September 2026	Sharon Hulbert	Kelly-Jane Wallis	Ines Epari

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Whitehaven Blackwater 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.

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Appendices

Appendix A **80th Percentile Summary Statistics and Comparison to Guideline Values**
Appendix B **Groundwater Modelling Technical Report**
Appendix C **Post Mining Period Starting Heads**
Appendix D **Predictive Hydrographs Adjacent Final Void Lakes**
Appendix E **Predictive Hydrographs at Third-Party Bores**

1.0 Introduction

1.1 Background

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Whitehaven Blackwater Pty Ltd (Whitehaven) to undertake a hydrogeological assessment supporting Revision 3 of the Blackwater Mine (BWM) Progressive Rehabilitation and Closure Plan (PRC Plan). This hydrogeological assessment is undertaken in accordance with the relevant requirements of the Queensland Government Department of Environment and Science (DES) Guideline: Progressive Rehabilitation and Closure Plans (DES Reference: ESR/2019/4964, version 3.01, effective 16 September 2024) - "the Guideline" and will be integrated into the design of the rehabilitation strategies and selection of post mining land uses (PMLUs) and Non-use Management Areas (NUMAs) within the BWM PRC Plan.

The BWM is located approximately 20 kilometres (km) south-west of Blackwater in the Bowen Basin, Queensland (**Figure 1-1**).

The BWM produces up to approximately 19 million tonnes per annum of (Mtpa) of Run-of-Mine (RoM) coal equating to approximately 16 Mtpa of product coal. The BWM strike length includes mining occurring in a number of separate and/or adjoining pits (**Figure 1-2**). Existing infrastructure is located primarily on ML1760 and includes a Train Load-out Facility (TLF) and coal stockpiles, RoM stockpiles, Coal Handling and Preparation Plant (CHPP), water management infrastructure and supporting infrastructure (i.e., roads, powerlines, laydown areas, workshop and administration areas).

BWM operates under Environmental Authority (EA) EPML00717813. The following Mining Leases (ML's) are included in the EA (**Figure 1-1**):

- ML1759
- ML1760
- ML1761
- ML1762
- ML1767
- ML70329
- ML1771
- ML1772
- ML1829
- ML1860
- ML1862
- ML1773
- ML1792
- ML1800
- ML1812
- ML1907
- ML70091
- ML70103
- ML70104
- ML70139
- ML70167

The most recent hydrogeological study relevant to the BWM PRC Plan is that undertaken for the BWM North Extension Project (SLR, 2026a), that included a post-mining assessment. That body of work has been drawn upon as directly relevant to this hydrogeological assessment, including the development of conceptual and numerical groundwater models for BWM as documented within SLR (2026a and 2026b).

For the purposes of this report:

- The Project Area is synonymous with the EA boundary (i.e. the area subject to EA EPML00717813) and is shown on **Figure 1-1**.
- The Study Area is the regional area surrounding the Project Area considered in detail within this report (**Figure 1-1**). The Study Area is also synonymous with the numerical groundwater model domain as discussed in **Section 8.0**.

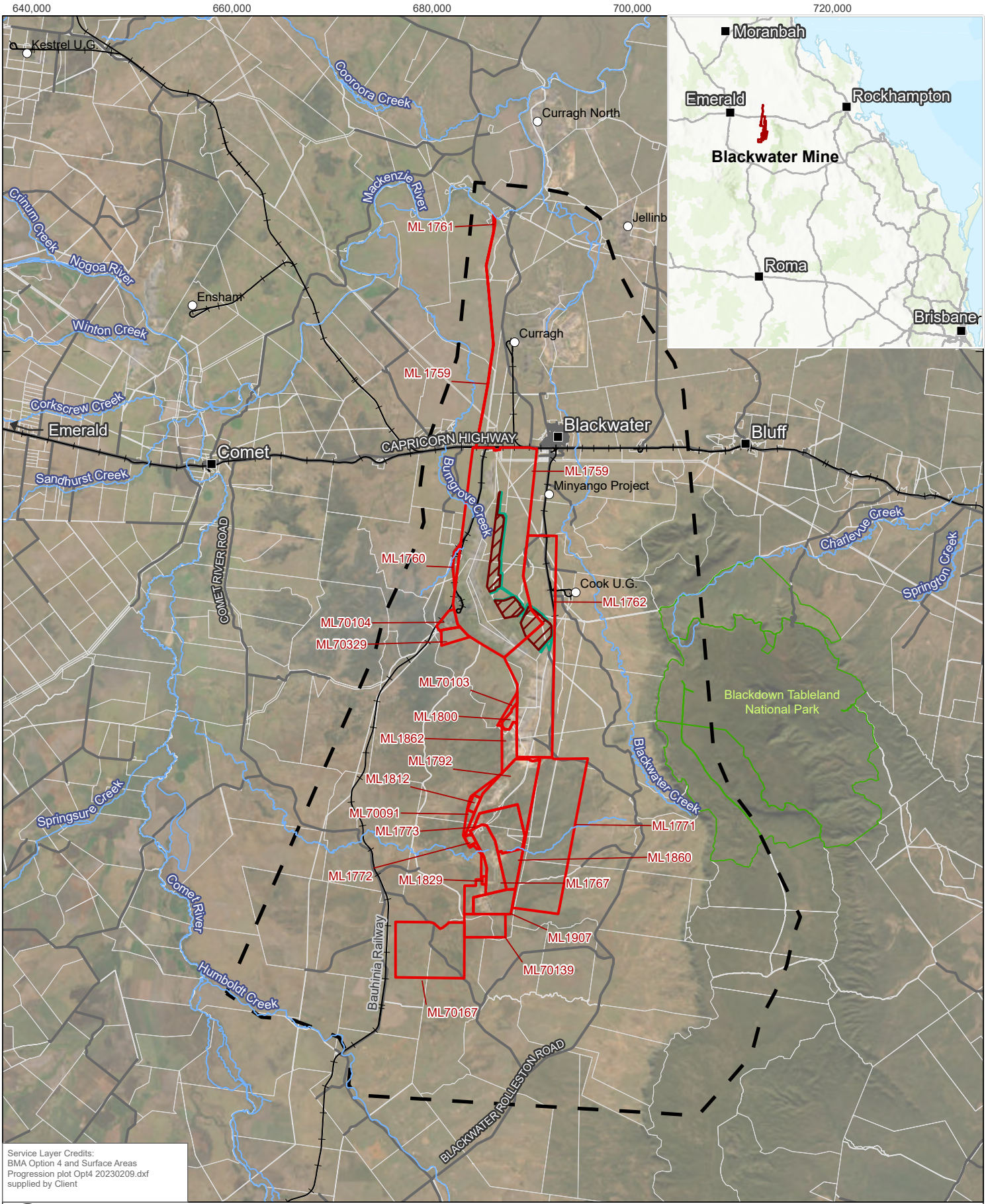
Mining commenced at BWM in 1967 and has included the extraction of coal through open cut strip mining from a series of pits (**Figure 1-2**). There were also six historical underground mining operations within the EA boundary (**Figure 1-2**):

- Kenmare Underground
- Laleham Underground
- Ballamoo Underground
- Highwall Mining (Augering)
- Sirius Creek No 1 Underground
- Sirius Creek No 2 Underground

1.2 Final Landform

The post-mining final landform relevant to this hydrogeological assessment, denoted “Final Landform Design 4.1” (Landform 4.1), was provided by Whitehaven and is shown as **Figure 1-3**. The final landform contains 15 residual voids/void areas, as shown on **Figure 1-3**, from north to south:

- Ramp 8;
- Bonnie Doon;
- Mimosa/Besgrove;
- R30;
- Deep Creek;
- Stewarton North;
- Stewarton South;
- Tannyfoil;
- South Ballamoo;
- Kenmare;
- R74;
- Togara/ North Marshmead;
- South Marshmead;
- Kennedy West; and
- Comet Downs East.



Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:500,000 at A4
Project Number:	620.040199
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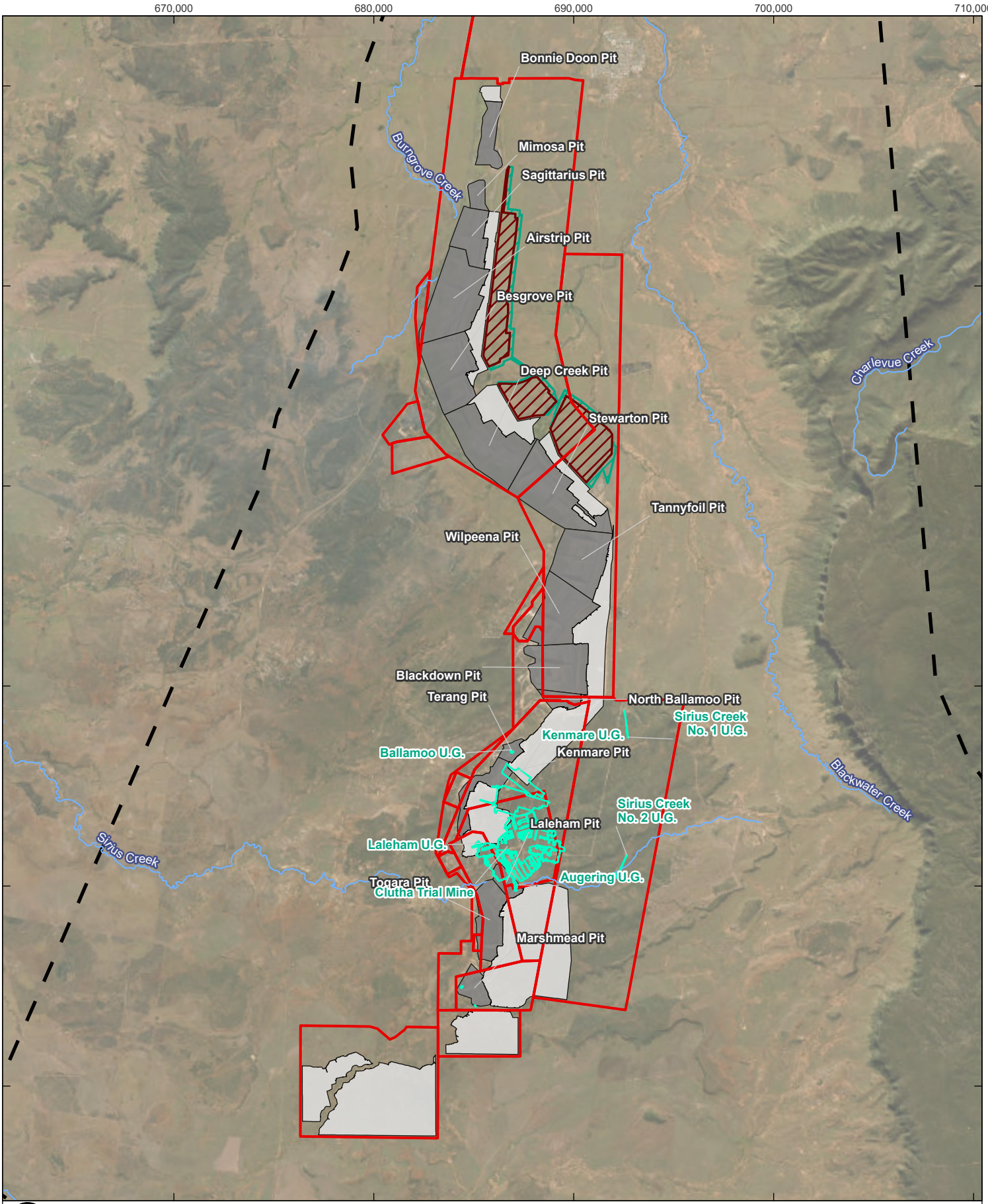
BLACKWATER MINE LOCATION

SLR

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FIGURE 1-1

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_F01_01_Project Location



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
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LEGEND

- Watercourse
- Historical Underground Mine
- BWM Mining Lease
- GIA Study Area
- Future Pit Extent
- Historical Pit Extent
- Proposed Open Cut Extension
- Proposed Infrastructure Area

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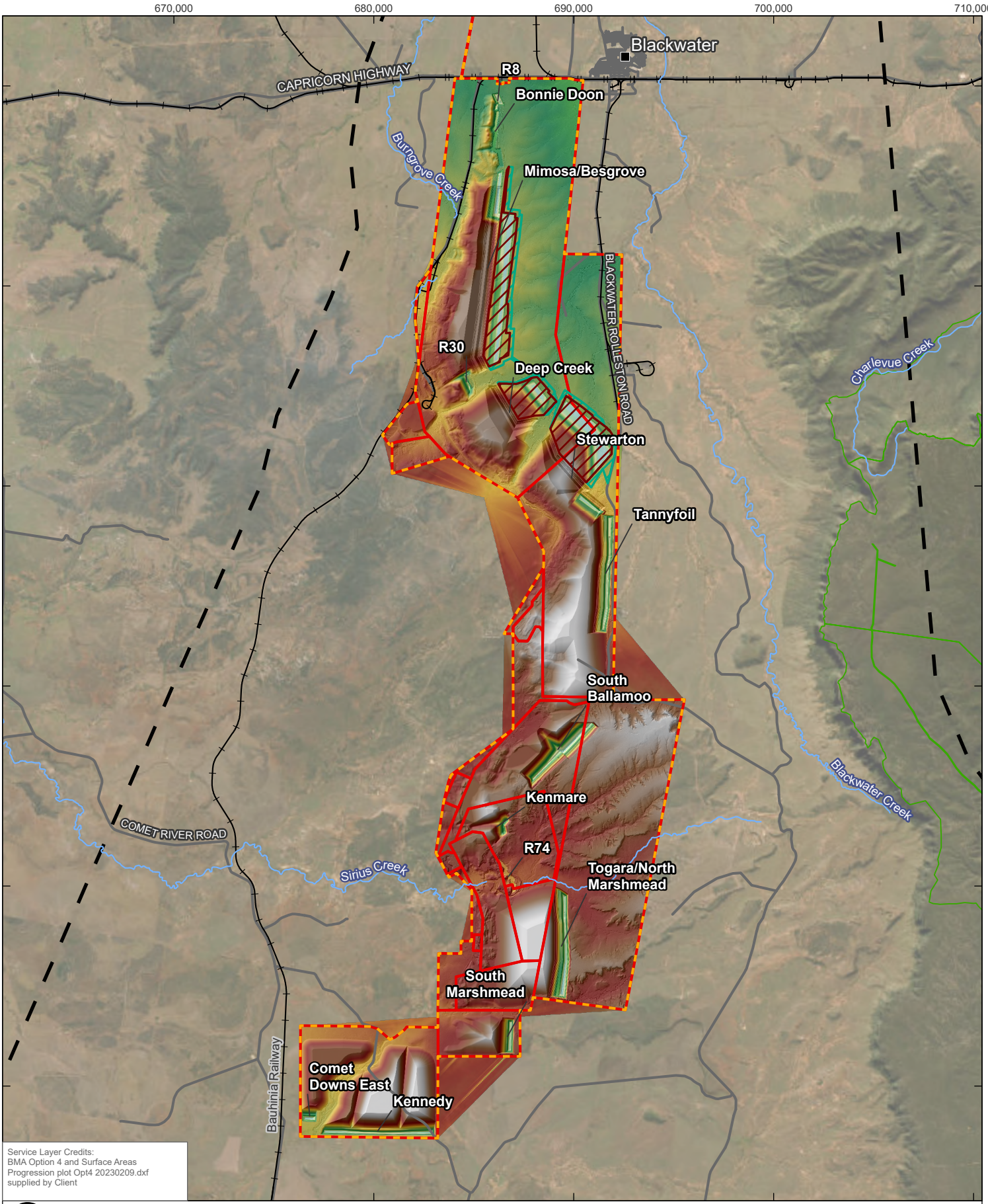
BWM MINING AREAS

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FIGURE 1-2

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_F01_02_BWM_Mining_Areas



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0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
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LEGEND

- City/Town
- Railway
- Road
- Watercourse
- Study Area
- BWM Mining Lease
- Project Area (Environmental Authorities boundary)
- National Park
- Proposed Infrastructure Area
- Proposed Open Cut Extension

Final Landform Elevation (mAHD)

450

-5

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

POST MINING LANDFORM

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FIGURE 1-3

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F01_3_Post Mining Landform

1.3 Objectives

The primary objective of the hydrogeological assessment is to assess the potential groundwater related impacts at BWM at completion of mining and until conditions stabilise post rehabilitation (i.e. groundwater equilibrium). A focus of the hydrogeological assessment is demonstrating suitability of the final landform for the intended post mining land uses (PLMUs) with respect of the BWM 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:
    - The final landform overall is demonstrated to be a sink 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 Dependent Ecosystem (GDE) locations.
    - Little to no additional groundwater drawdown at anthropogenic bore users.

Potential impacts associated with mine-related sources of potential groundwater contamination at BWM are being assessed for the PRC Plan by separate specific assessments. Consequently, this hydrogeology assessment focuses on the larger scale potential impacts to the site groundwater system.

1.4 Guideline Criteria

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

Table 1-1 Guideline Requirements

Guideline Requirement	Section of this Report
Section 3.6.1 General rehabilitation practices – Hydrogeology	
Determining the groundwater occurrence including the existence of, and depth to, aquifers and aquitards	**Section 4.0** **Section 4.3**
Locating groundwater recharge and discharge locations locally and regionally	**Section 4.3**
Groundwater quality within each of the aquifers and from surface expressions (i.e. seeps and springs)	**Section 5.0**
Current and potential future uses of groundwater including existing groundwater extraction bores	**Section 5.1.3** **Section 5.2**
Groundwater flow direction and velocity, including field tests to determine hydraulic conductivity	**Section 4.1.1**
The development of potentiometric mapping and hydro stratigraphic cross sections	**Section 4.3** **Section 6.0**
Groundwater modelling to determine contaminant transport and potential changes to groundwater level from dewatering or waste storage.	**Section 8.0**
Section 3.6.4 Underground mining – Hydrogeology	
An assessment of groundwater interactions and potential lowering of groundwater levels	**Section 8.2.5**
The development of a hydrogeological conceptual model	**Section 6.0** **Section 9.0**
A numerical model to enable analytical assessment of the hydrological evolution within the underground workings post closure	**Section 8.0**

2.0 Physical Setting

2.1 Climate

The climate of the Study Area is sub-humid/sub-tropical, with a distinct wet and dry season. Historical climate data was obtained for the period from January 1970 to February 2026 from the Scientific Information for Landowners (SILO) database (Queensland Government, 2025). Data from the BWM weather station is limited to a short record of rainfall data. Therefore, the SILO climate record for grid point data -23.70, 148.85, which lies within the EA Boundary, is used to understand long-term climate trends. Rainfall data from the BWM site weather station is only available from January 2016 to January 2025. A comparison between monthly rainfall, as recorded at the BWM site weather station, and monthly rainfall from the SILO climate record is presented on **Figure 2-1** for the most recent year of complete available data (being 2024). The two data sets generally correlate well over the overlapping period, which justifies using the SILO climate record data to understand long-term climate trends and the climate input for the Project groundwater modelling (**Section 8.0**).

Long-term average monthly rainfall, Moreton's areal actual evapotranspiration and Class A Pan evaporation from SILO is presented in **Table 2-1**. The Study Area is characterised by a long-term average rainfall of approximately 549 mm per year, with wetter conditions during the summer months of December, January and February and relatively dry conditions during the remainder of the year. As shown in **Figure 2-2** average monthly evaporation and evapotranspiration exceed rainfall in all months. Within the Study Area, the highest rate of evapotranspiration occurs along creek lines, where the water table is closer to ground surface and deeper-rooted vegetation is present.

To place rainfall over the years into an historical context, cumulative rainfall departure (CRD) was calculated for the period of January 1970 to February 2026 (**Figure 2-3**). This is a summation of the monthly departures of rainfall from the long-term average monthly rainfall. A rising slope in the CRD plot indicates periods of rainfall above the long-term average, as is the case from March 2022 to December 2022, whereas a falling slope indicates periods when rainfall is below the long-term average (e.g. February 2018 to September 2021). Rainfall volumes over the more recent period of the record (i.e. December 2022 to February 2026) have been reasonably average, as is indicated by the roughly horizontal trend in the CRD (**Figure 2-3**).

In addition, the CRD is used to assess the recharge of groundwater via rainfall. Where observed groundwater level trends mimic the pattern of the CRD curve, it is considered that natural fluctuations in the groundwater table can result from temporal changes in rainfall recharge to groundwater systems. Typically, changes in groundwater elevation can reflect the deviation between the long-term monthly (or yearly) average rainfall, and the actual rainfall, as illustrated by the CRD. The CRD and observed groundwater levels are discussed as a means to characterise climatic conditions within the assessment of groundwater levels (see **Section 4.3**).

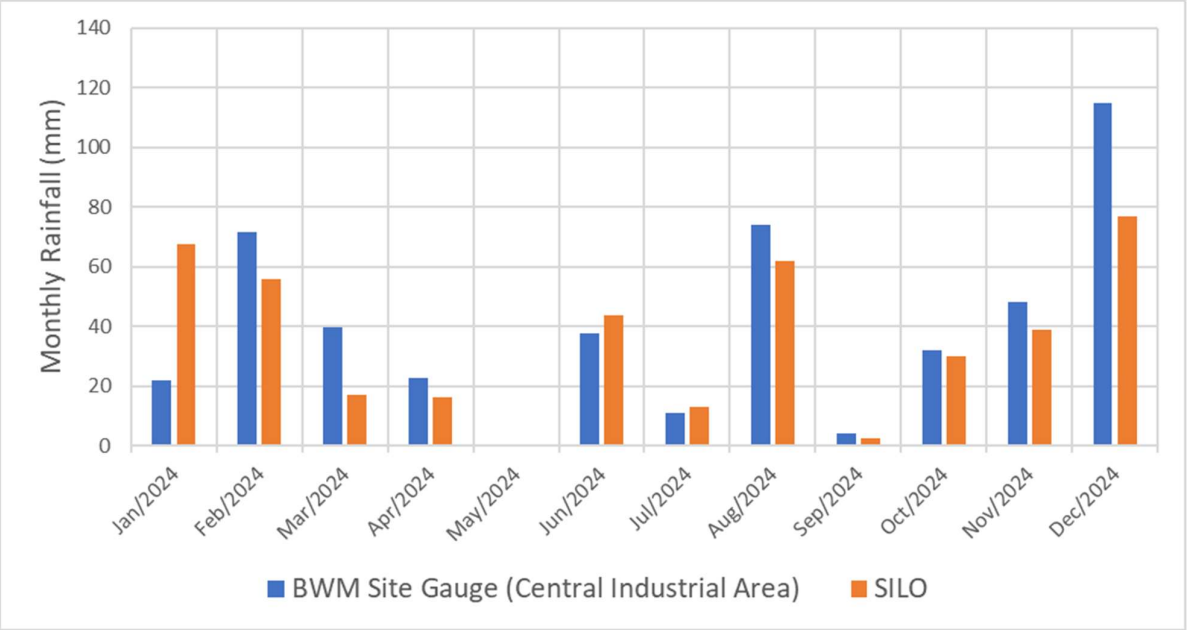


Figure 2-1 Monthly Rainfall at the BWM Site Station and SILO Data Location (2017-2024)

Table 2-1 Total Monthly Rainfall, Evaporation and Evapotranspiration (January 1970 to February 2026)

Average Total Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall (mm)	89	74	49	29	32	23	22	17	23	45	62	84	549
Evaporation (class A Pan) (mm)	230	186	189	148	114	90	99	130	171	213	225	241	2,037
Evapotranspiration (Moreton's areal actual) (mm)	135	114	106	68	43	31	35	52	71	99	115	134	1,002

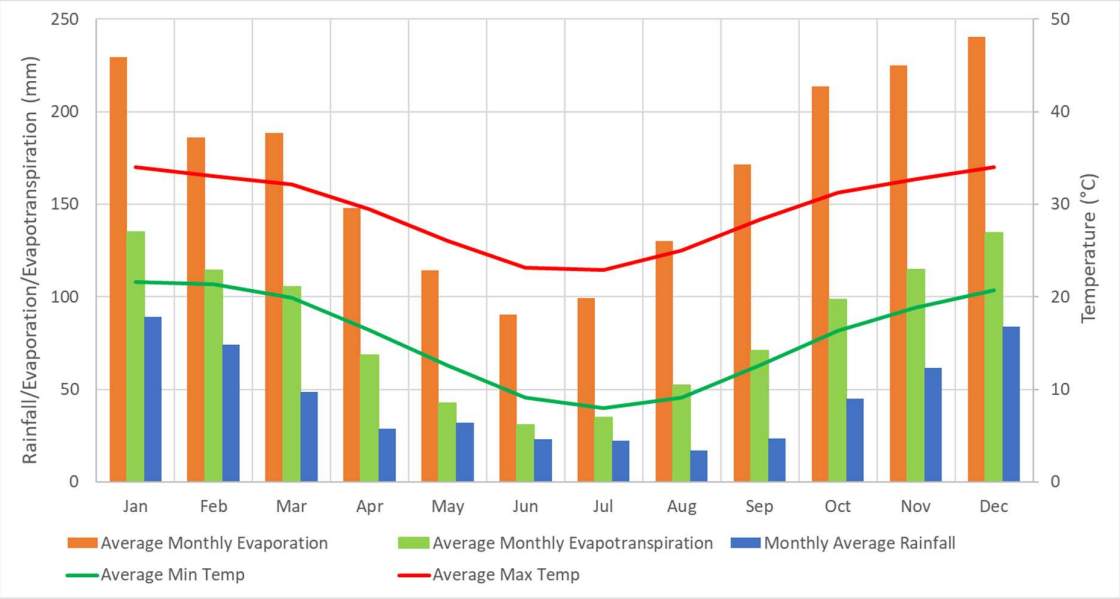


Figure 2-2 Average Monthly Evaporation, Evapotranspiration, Rainfall and Temperature (January 1970 to February 2026)

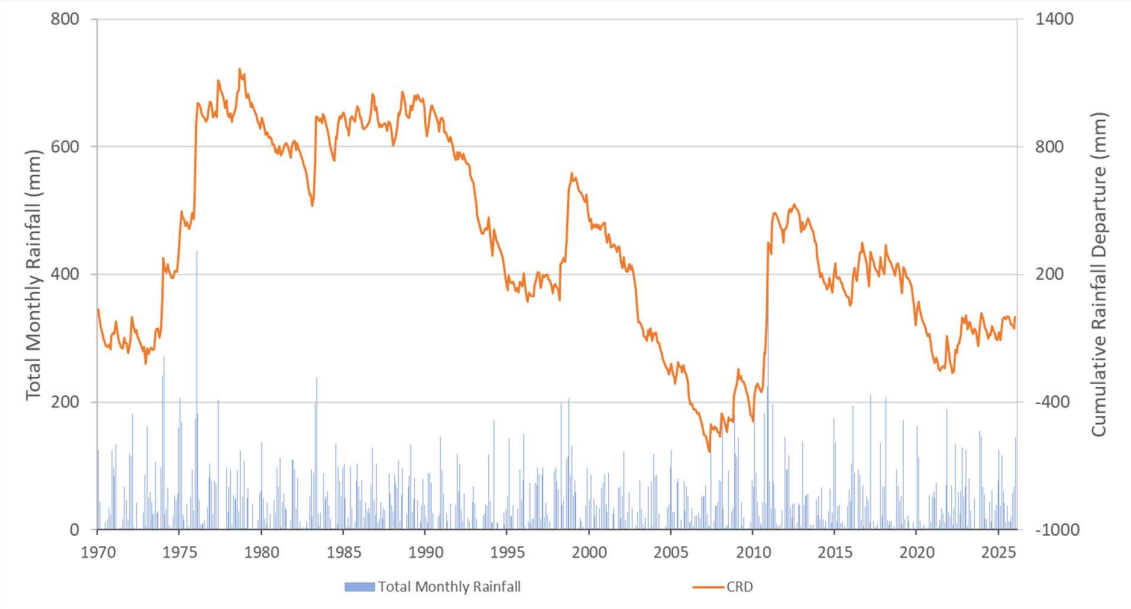


Figure 2-3 Cumulative Rainfall Departure and Total Monthly Rainfall

2.2 Topography and Drainage

The Study Area topography is relatively flat, with elevations of 280 mAHD in the south to around 150 mAHD in the north, at an average gradient of between 1:100 and 1:240. To the south of BWM, there are hills with elevations around 350 mAHD, which form the catchment divide between the Mackenzie and the Comet sub-catchments (**Figure 2-5**).

Approximately 10 to 15 km to the east of BWM, toward the eastern boundary of the Study Area, there is an escarpment formed by outcrop of the Clematis Group sandstone, which reaches an elevation up to 750 mAHD.

BWM is located across two surface sub-catchments of the Water Plan (Fitzroy Basin) 2011:

- The Upper Mackenzie sub-catchment, which is located within the northern portion of BWM and,
- The Comet sub-catchment, which is located within the southern portion of BWM (**Figure 2-5**).

The surface drainage comprises several ephemeral creeks that are tributaries of the Mackenzie and Comet Rivers. Creeks that flow in the Upper Mackenzie sub-catchment drain from south to north towards the Mackenzie River, whilst creeks that flow in the Comet sub-catchment drain from east to west towards the Comet River. The Project Area is located in the Mackenzie sub-catchment and the most prominent drainage feature in the area is Blackwater Creek.

The ephemeral creeks have intermittent flow, and typically only contain water after high intensity rainfall events (AGE, 2003). **Figure 2-4** shows the average daily water level in Blackwater Creek (Blackwater Creek D/S monitoring point as shown on **Figure 2-5**) compared to the daily rainfall (SILO climate record, refer to **Section 2.1**). After large rainfall events, generally considered to exceed approximately 30 mm/day, flow is recorded in the creek. Creek flows subsequently recede during drier periods.

Groundwater interaction with ephemeral creeks is considered unlikely within the Study Area.

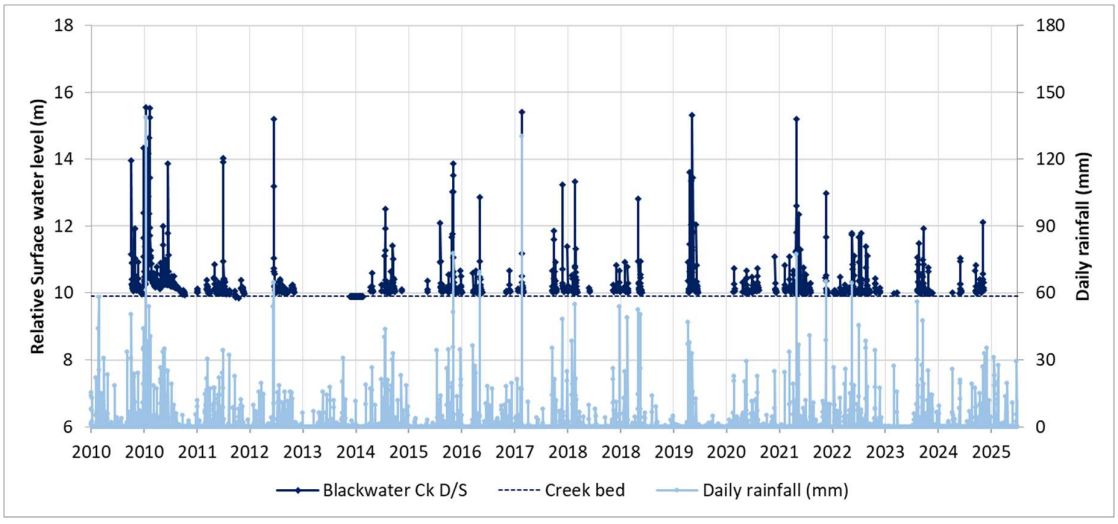
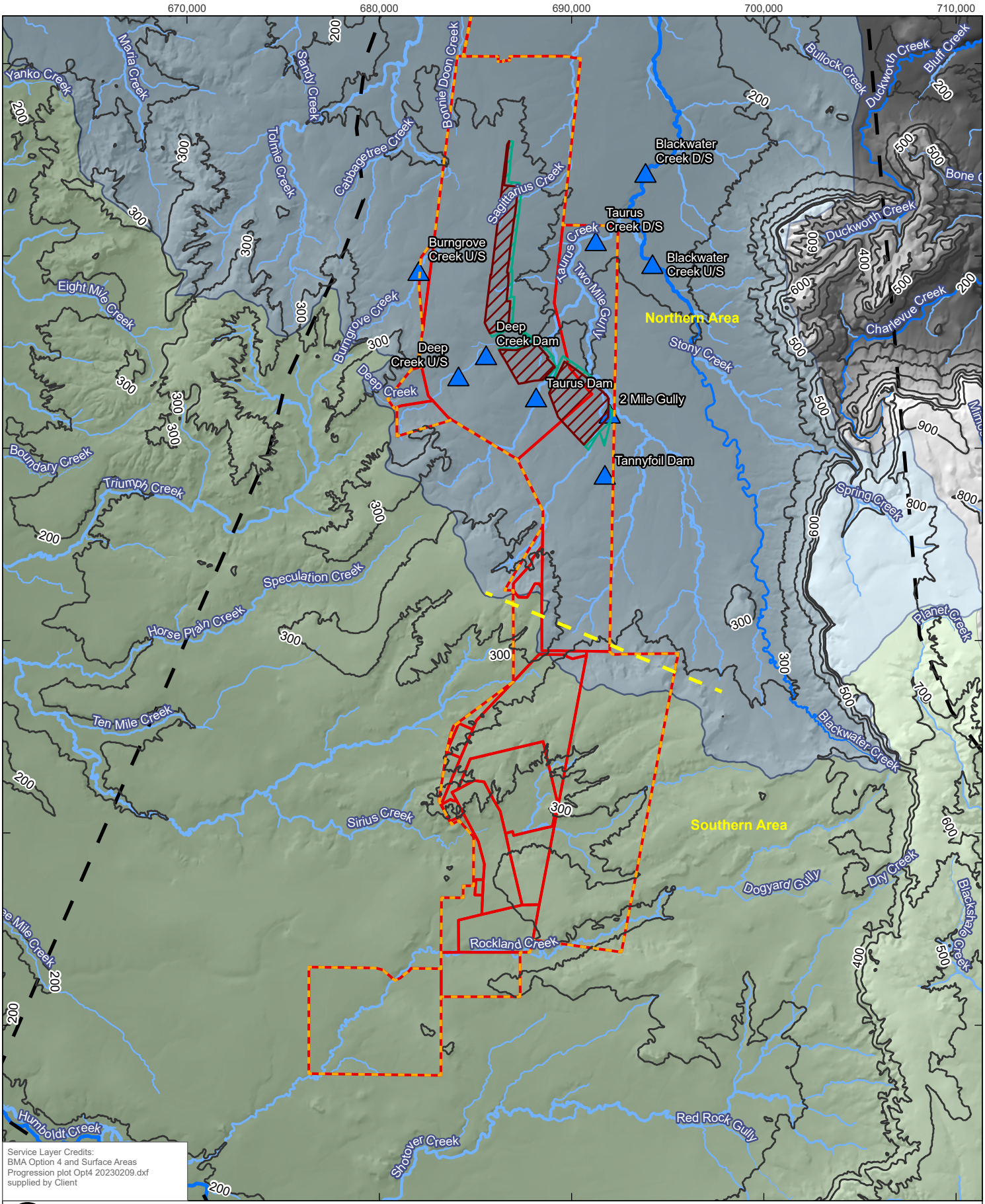


Figure 2-4 Average Daily Water Levels in Blackwater Creek D/S



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0 2.5 5 km

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LEGEND

- Surface Water Monitoring Site
- Major Watercourse
- Minor Watercourse
- Topographic Contour (mAHD)
- Study Area
- BWM Mining Lease
- Project Area (Environmental Authorities boundary)
- Area

Fitzroy Basin (2011) Water Plan Sub-catchment

- Comet
- Upper Mackenzie
- Proposed Infrastructure Area
- Proposed Open Cut Extension

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

TOPOGRAPHY, DRAINAGE AND WATER PLANS

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FIGURE 2-5

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F02_4_Topography and Drainage

2.3 BWM Mining

This section outlines the historical mine progression and future mining plan at BWM, as relevant to assessing the effect of BWM on the groundwater system post-closure. This is considered important since post-closure groundwater conditions will in part be dictated by the conditions that are present as a result of existing mining activities at the time of closure.

2.3.1 Historical Mining Activities

BWM began operations in 1967. **Table 2-2** lists the operating areas of BWM with the estimate of commencement date and target seams. **Figure 2-6** provides a locality plan and timing for historic BWM mining. Note that prior to the early 2000's, BWM operated as two separate mining operations, commonly denoted "Blackwater" and "South Blackwater", which were merged in late 2000 with BMA's acquisition of the South Blackwater operation.

In all pits, spoil is deposited to the west of mine void adjacent to the pit ramps. The primary mine operations area including stockpile, workshops, coal processing facility and three tailings storage areas (CHPP Tailings Storage in the north of BWM, and R72 Tailings Storage Dam and R74 Tailings Storage Dam in the central part of BWM; see **Section 2.3.3**).

In addition to open pit mining operations, there are multiple historical underground mines located within the Project Area as shown on **Figure 1-2** and detailed in **Table 2-2**.

Table 2-2 BWM Historic Mining Areas and Basal Target Seams

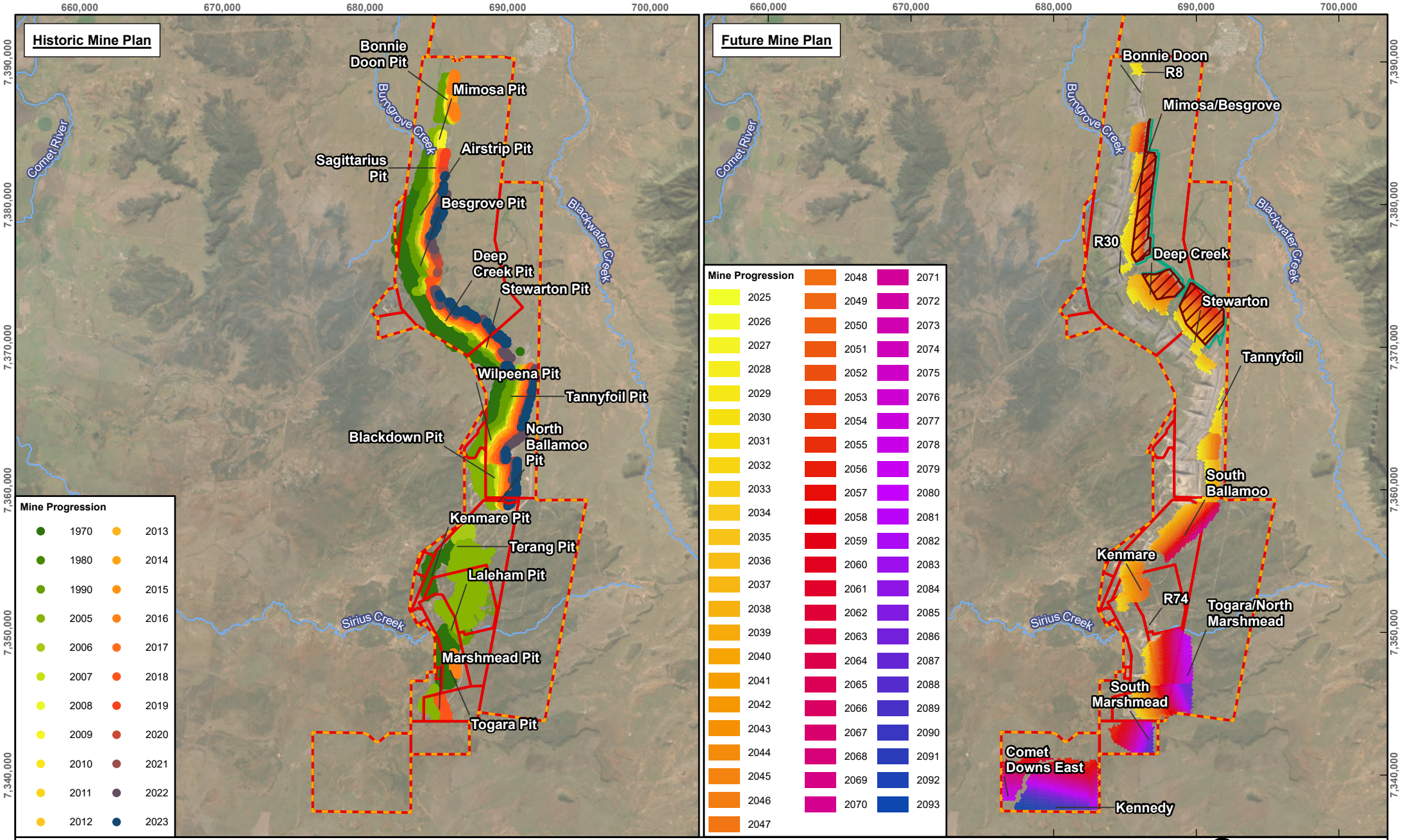
Mine Area Name	Mining Commenced	Mining Completed	Deepest Target Seam
Open Pit Mining			
Bonnie Doon Pit/R08N	1998 – 2002	2016	P1U
Mimosa Pit	2002 - 2003		P1L (part of final void Mimosa/Besgrove)
Sagittarius Pit	1973 - 1978	2088	P1L (part of final void Mimosa/Besgrove)
Airstrip Pit	1973 - 1978	2061	P1L (part of final void Mimosa/Besgrove)
Besgrove Pit	1973 - 1978	2065	P1L (part of final void Mimosa/Besgrove)
Deep Creek Pit	1973	2049	P1L
Stewarton Pit	1973	2039	P1L
Tannyfoil Pit	1973 - 1978	2039	P1L
Wilpeena Pit	1973 - 1978	2040	P1L
Blackdown Pit	1984 - 1993	2048	P1L
North Ballamoo Pit	1984 - 1993	2094	P1L
Terang Pit	1973 - 1978	2090	L1
Kenmare Pit	prior to 1978	2094	L1
Laleham Pit	prior to 1973	2090	TR75
Togara Pit	1973 - 1984	2109	L10
Marshmead Pit	1984 - 1993	2109	L10
Underground Mining			
Kenmare Underground Mine	1994 - 1997[^]	Kenmare 1 2001[^] Kenmare 2 incorporated to surface excavation[^]	Pollux[^]

Mine Area Name	Mining Commenced	Mining Completed	Deepest Target Seam
Augering Underground Mine			
Ballamoo Underground Mine			
Clutha Trial Mine			Aries^
Laleham Underground Mine	1969^	2001*	Pollux^
Sirius Creek No. 1. Underground Mine		1970s*	Aries^
Sirius Creek No. 2. Underground Mine		1970s*	Aries^

^ Byrnes Geotechnical (2024)
* EMM (2021)

2.3.2 Current and Future Mining

Mining at BWM is expected to continue on the current approved operations until July 2113. The current mine plan, with polygons indicating timing for mine strip extraction is provided on **Figure 2-6**. This involves continued mining targeting economic areas of Rangal Coal Measures seams dipping down generally eastwards in the north and central parts of BWM and east/southeast in the southern part of BWM, with basal depth of mine void increasing in conjunction with the dipping geology.



Scale: 1:340,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 05-May-2026
Project Number: 620.040199

Watercourse

Project Area (Environmental Authorities boundary)

BWM Mining Lease

Proposed Infrastructure Area

Proposed Open Cut Extension

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BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

HISTORICAL AND FUTURE MINE PROGRESSION

FIGURE 2-6

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F02_6_Historical and Future Mine Progression without SA7

2.3.3 Surface Water Management

Surface water management practices are relevant to this hydrogeological assessment through potential for interaction in seepage to or from mining water handling areas. The water storage areas at BWM are shown on **Figure 2-7** and information for key surface water management locations considered to have potential to interact with local groundwater is provided in **Table 2-3**.

Table 2-3 BWM Key Surface Water Management Locations

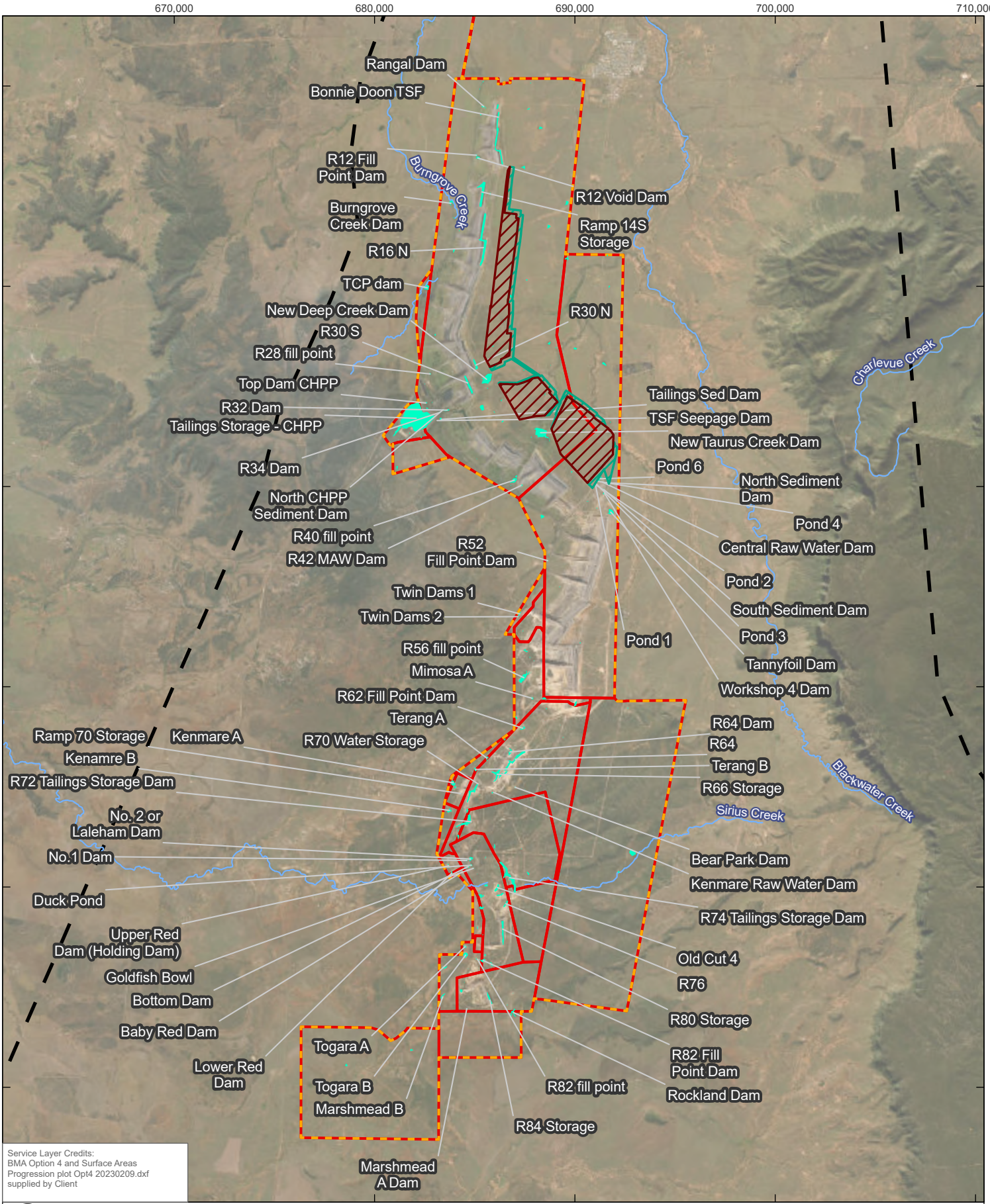
Water Storage Name	Type	Area (ha)	Last Recorded Storage RL Date	Last Recorded Storage RL (mAHD)
Tailings Storage – CHPP	Tailings	147.1		
Bonnie Doon TSF	Tailings	17.8	19/10/2025	143 – 146.6*
Duckpond	Dam	0.8	19/10/2025	266.3
Lower Red Dam	Dam	1.6	19/10/2025	267.5
New Deep Creek	Dam	16.7	19/10/2025	213.3
New Taurus Creek Dam	Dam	22.8	19/10/2025	213.2
Old Cut 4 (ramp74 dam)	Dam	4.1	19/10/2025	254.5
Ramp 10 N-North (ramp 8N)	Pit water	4.0	19/10/2025	145.0
Ramp 12 Dam (fill point void)	Dam	0.6	18/11/2024	195.9
Ramp 14 South	Pit water	17.4	19/10/2025	184.0
Ramp 16	Pit water	29.3	19/10/2025	118.4
Ramp 30 South	Pit water	9.3	19/10/2025	150.3
Ramp 64 & 66 (RL281.2-285)	Pit water	24.3	19/10/2025	283.1
Ramp 70	Pit water	9.1	19/10/2025	277.6
Ramp 72 Tailings	Tailings	12.1	19/10/2025	287.0
Ramp 74 Tailings	Tailings	23.9	19/10/2025	247.2
Ramp 76	Pit water	2.5	19/10/2025	241.7
Ramp 80	Pit water	8.9	19/10/2025	243.5
Ramp 84	Pit water	4.7	19/10/2025	215.1
SBW Bottom Dam	Dam	0.9	19/10/2025	274.5
SBW No2 (Laleham) Dam	Dam	2.7	19/10/2025	274.3
Tannyfoil Dam	Dam	5.6	19/10/2025	234.1
TCP Storage	Dam	4.6	19/10/2025	223.1
Upper Red (Holding) Dam	Dam	0.9	19/10/2025	276.6

* level range including tailings and water

2.3.4 Mine Pit Groundwater Inflow

During active mining operations, groundwater inflows to active pit voids are generally small in volume and do not need to be actively managed via advance dewatering or other groundwater management methods, with evaporation from the pit walls and floors accounting for most of the groundwater volume. Small volumes of groundwater inflow requiring management within active mine pits, when they occur, are generally managed via the use of in-pit sumps to capture water that is then used or circulated via the Mine water management system for use in coal washing and for dust suppression purposes.

Numerical groundwater modelling completed by SLR (2026b) indicated that groundwater inflows to the current BWM operation (year 2026) approximate 2,600 ML/year (~4.38 ML/day). Annual pit inflows calculated by Whitehaven from the latest site water balance calibration for the most recent complete water year, being 1st July 2024 to 30 June 2025, were estimated to be 821 ML/yr (~2.25 ML/day) (S. Peignelin, pers. Comm., 22 July 2025). This difference is to be expected as site water balance models typically account only for groundwater physically managed within the water system. They do not include water lost through passive evaporation from pit walls and floors or water retained in mined rock, which are volumes accounted for within a numerical groundwater model.



Service Layer Credits:
BMA Option 4 and Surface Areas Progression plot Opt4 20230209.dxf supplied by Client

0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	05-May-2026
Drawn by:	JWP

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LEGEND

- Watercourse
- BWM Mining Lease
- Project Area (Environmental Authorities boundary)
- Study Area
- Water Storage Area
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

CURRENT BWM WATER STORAGE AREAS

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FIGURE 2-7

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F02_07_Current Blackwater Water Storage Areas

3.0 Geology

3.1 Regional Geology

BWM is located in the Bowen Basin, which is one of five major foreland sedimentary basins formed along the eastern side of Australia during the Permian geologic period. The Bowen Basin is the largest productive coal basin in Australia. The north-south oriented Bowen Basin stretches from Townsville in the north, to the Queensland-New South Wales border in the south.

The stratigraphic sequence of the Study Area is presented in **Table 3-1**. From youngest to oldest, the stratigraphic sequence across the Study Area primarily comprises unconsolidated Quaternary aged sediments that unconformably overlie consolidated Triassic and Permian aged sequences (**Figure 3-1).** The Permian and Triassic strata form regular layered fluvio-deltaic sedimentary sequences, while the Quaternary sediments are more complex and irregular. The coal deposits extracted from BWM are found within the Rangal Coal Measures, which is the uppermost Permian unit (**Figure 3-2**).

Overlying the consolidated basal units, Tertiary sediments and basalt, and Quaternary alluvium, are present as cover. At the eastern extents of the Study Area, the Triassic aged Clematis Group outcrops with a dramatic change in topography associated with the comparatively weathering resistant sandstones of that geologic unit (refer to **Section 2.2**).

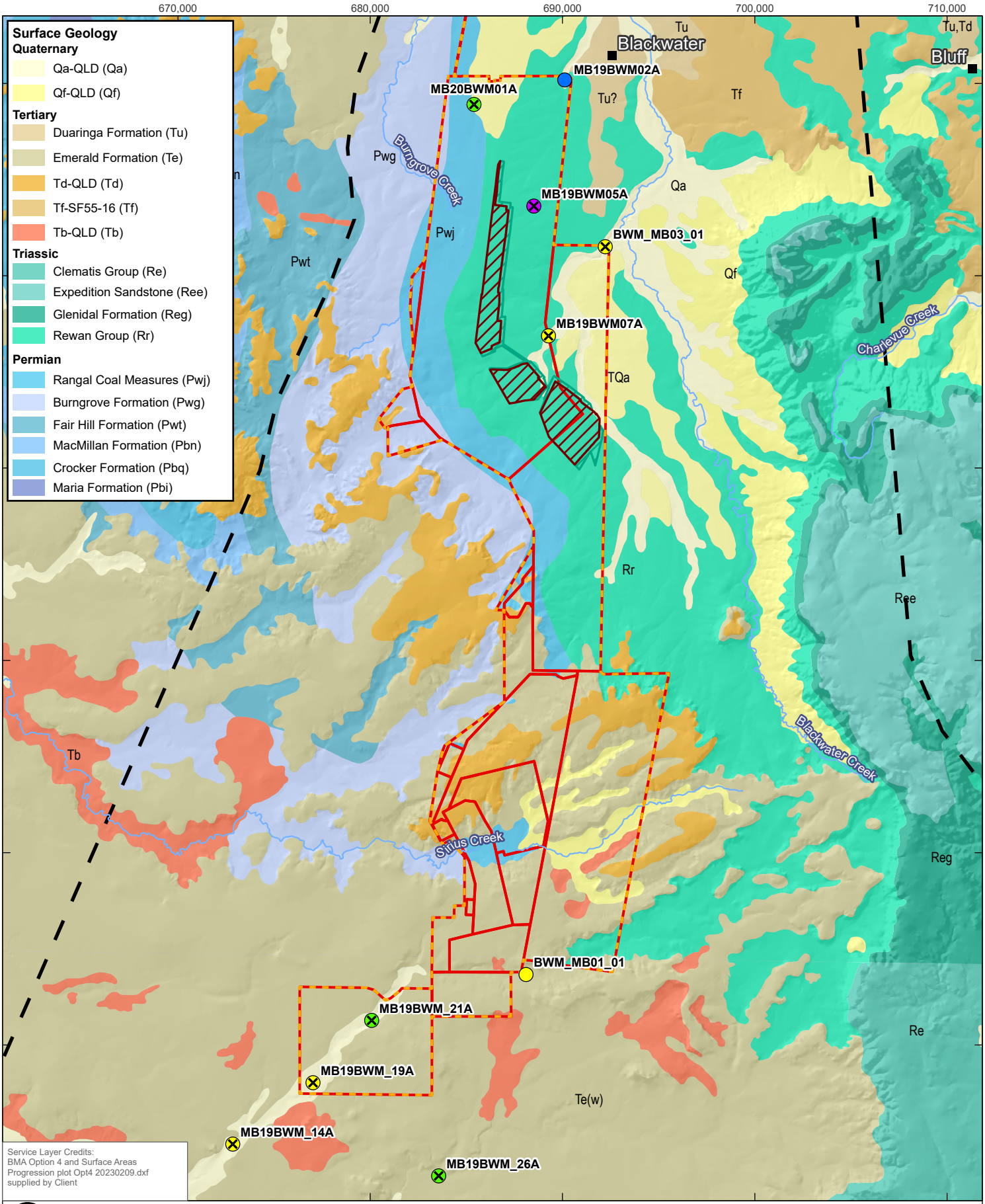
Each of the main stratigraphic units relevant to BWM are discussed in **Section 3.2.1** to **Section 3.2.6**, and the structural geology is discussed in **Section 3.1.1**.

Table 3-1 Summary of Stratigraphy in the Study Area

Age	Unit	Thickness (m)	Description
Quaternary	Alluvium	0.5 - 12	Alluvium - silt, clay, sand and gravel.
Tertiary	Basalt	30	Weathered basalt soils, residual basalt. Moderately weathered and fresh basalt.
	Sediments/ sedimentary units	30	Clays, sandstones, sands, gravels, often poorly consolidated (Tu, Te(w), Tf and TQa). Regional mapping shows highly weathered Tertiary sediments display some areas of duricrust (Td) and partially cemented fanglomerate (Tf)
Triassic	Clematis Group	100-800	Weathering resistant medium to coarse grained quartzose to sublabile and micaceous sandstone, siltstone, mudstone and conglomerate.
	Rewan Group	50-300	Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate (at base); deposited in a fluvial-lacustrine environment. Occurs 2m to 6m above the Aries seam.
Permian	Rangal Coal Measures	100	Feldspathic and lithic sandstone, carbonaceous mudstone, siltstone, tuff and coal seams. Coal seams include the Aries, Castor, Pollux and Orion and Pisces seams. The Pollux and Orion seams commonly coalesce into a single seam, which is referred as the Argo seam.
	Burngrove Formation	170	Sandstones, siltstones and mudstones, and banded coal seams frequently interbedded with tuff and tuffaceous mudstones. Coal seams include the Virgo and Leo seams.

Note: Source AGE (2008), AGE (2013) and EMM (2019).





0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:260,000 at A4
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LEGEND

- City/Town
- Watercourse
- Study Area
- BWM Mining Lease
- Project Area (Environmental Authorities boundary)
- Dry

Drilling Targeting Alluvium

- Alluvium
- Tertiary
- Rewan
- Rewan (weathered)

- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

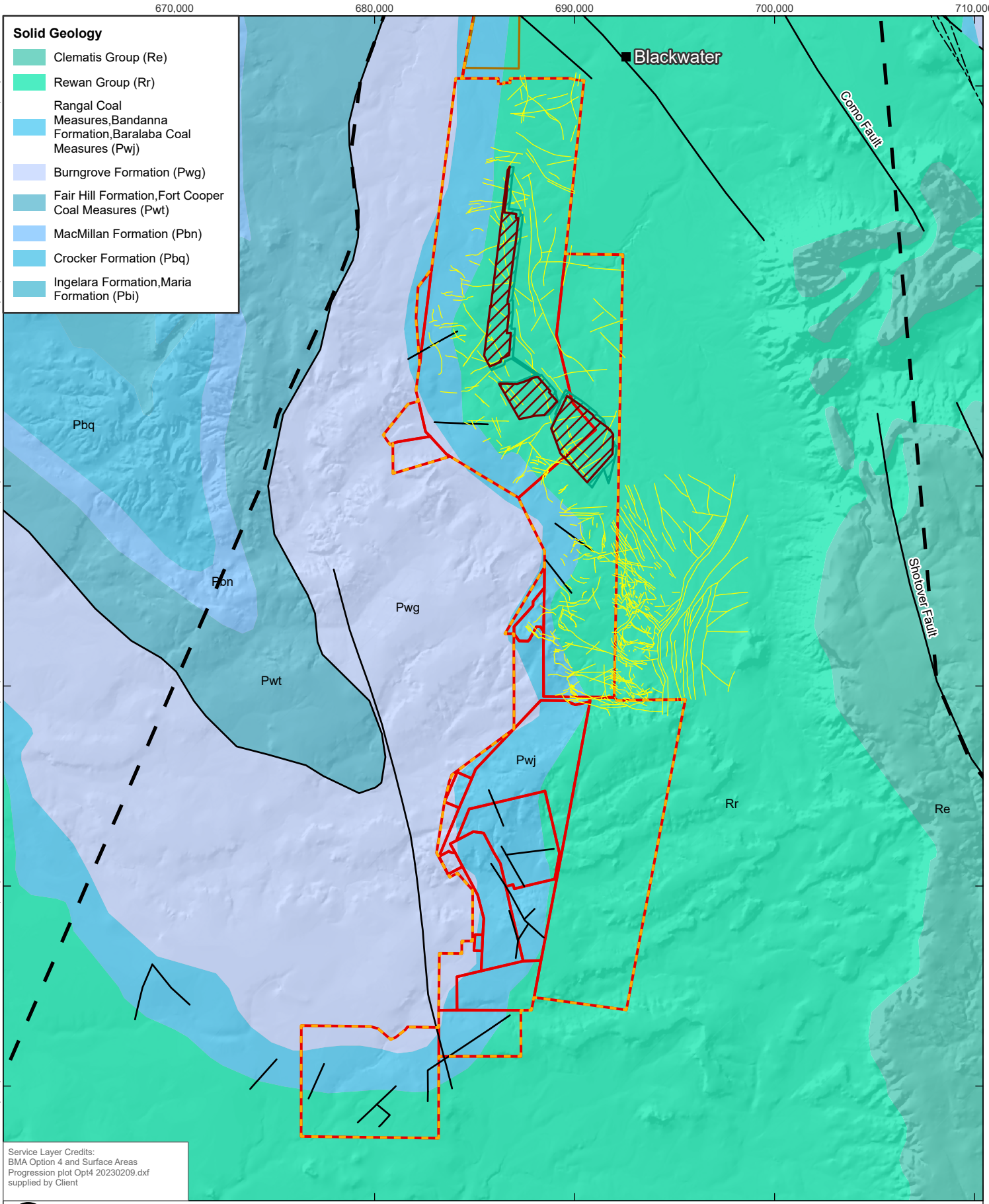
SURFACE GEOLOGY AND DRILLHOLES TARGETING ALLUVIUM

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FIGURE 3-1

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F03_1_Surface Geology



Coordinate System:	GDA2020 MGA Zone 55
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BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

SOLID GEOLOGY

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FIGURE 3-2

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F03_2_Solid Geology

3.1.1 Structural Geology

The structural geology in the region is characterised by gently folded consolidated sediments and a major north to north-west striking fault system which forms the Jellinbah Thrust fault system (AGE, 2013). A series of easterly dipping thrust faults occur parallel to the Jellinbah Thrust, including the Shotover Fault (occurring to the east of the Study Area where the Clematis Group outcrops) and the Como Fault that runs through the Curragh Mine (**Figure 3-2**) (Mallet et al., 1985). Regionally the structure is defined as a faulted monoclinal limb (AGE, 2013).

The strata in the vicinity of the BWM are heavily influenced by a series of easterly dipping, north to northwest striking faults (AGE, 2008). The Shotover Fault is of major importance as there is a displacement of up to 3,000 m (AGE, 2013). Locally, thrust faulting that occurs within the BWM may be attributed to thrusts occurring in the footwall of the Shotover Fault. Local structure is influenced by strike slip movement of basement rocks. Local fault displacement is reported to be less than five meters on average but can reach up to 20 m (AGE, 2008). **Figure 3-2** also shows the numerous local faults mapped within the Study Area. The local faults were mapped by historical tenement holders (BM Alliance Coal Operations Pty Ltd [BMA]) and the regional faults were sourced from the public database (Qld Government, 2004).

3.2 Local Geology

The geology of the Project Area is discussed in **Sections 3.2.1** to **3.2.6** below.

3.2.1 Quaternary Sediments

The Quaternary alluvial sediments unconformably overlie the Triassic Rewan Group and Permian coal measures. The unit consists of a thin surficial cover of generally unconsolidated clays, silts, sands and gravels associated with floodplains of the major drainage channels, primarily Blackwater Creek. Drilling data from within the Study Area shows that the alluvial sequence varies from approximately 0.5 to 16 m thick.

Recent drilling at BWM has shown that alluvium associated with the creeks, is not always present and extents are limited. In 2020, four bores were attempted to be installed into the alluvium near north BWM (Taurus Creek, Sagittarius Creek and Two Mile Gully), however only one drillhole at Taurus Creek found sufficient alluvial sediments which was completed as a dry bore (AGE, 2020). In 2021 another bore targeted the alluvium at Sagittarius Creek, however upon drilling, the alluvial sediments were again deemed insufficient at the site, so the bore was installed into the underlying Rewan Group instead (HydroFS, 2021). Further discussion of drilling attempts in the alluvium and groundwater occurrence is provided in **Section 4.3.1.** Based on these investigations, it is considered that the extent of the alluvium within the Study Area is likely smaller than mapped on the regional surface geology map. **Figure 3-1** shows the location of the drilling that attempted to target to the alluvium, whilst illustrating what unit the bores were resultingly screened in.

3.2.2 Tertiary Sediments and Basalt

Tertiary and basalt units unconformably overlie the Triassic and Permian units. The unit consists primarily of unconsolidated/weathered Tertiary Sediments and weathered

claystone, siltstone and sandstones. The unit varies in thickness ranging from 5 to 50 m with a maximum thickness of 115 m, typically thicker to the south.

Based on drilling results, the Tertiary sediments in the southern Project Area are thicker on average than in the northern Project Area. In this area they primarily consist of claystone, siltstones, sandstones and interbedded basalt of the Emerald Formation.

Toward the south and southwest of the Project Area, basalt flows are present (**Figure 3-1**). The basalts have been described as having varying degrees of weathering and thickness, from moderately weathered thin flows (intersected in ML 70167 in the Humboldt area) to thicker and more fresh flows (intersected slightly further north in ML 70139 in the South Marshmead area). The basalt flows vary in thickness ranging from to 10 to 42 m (AGE, 2003).

3.2.3 Triassic Clematis Group

The Clematis Group unconformably overlies the Rewan Group and outcrops on the eastern margins of the Study Area, where it forms an elevated plateau and escarpment (**Figure 3-2**).

The unit is comprised of weathering resistant medium to coarse grained quartzose to sublabile and micaceous sandstone, siltstone, mudstone and conglomerate. In the Study Area, the Clematis Group is made up of the Glenidal Formation and Expedition Sandstone members which are estimated to form an average thickness in the range of 100 to 800 m (Geoscience Australia, 2021).

3.2.4 Triassic Rewan Group

The Rewan Group overlies the Permian coal measures and occurs as in-fill material, thickening to the east with the dip of the coal measures, and thins to the west where the coal measures occur at outcrop (**Figure 3-1**). Where present, the Rewan Group has a distinct greenish tint (non-marine deposits containing glauconite) and is composed of siltstone and mudstone, with interbeds of lithic and volcanic sandstones.

Based on exploration drill holes and groundwater bore holes in the Study Area, the Rewan Group is comprised of siltstone and mudstone, with interbeds of lithic and volcanic sandstones and is of variable thickness ranging between approximately 50 to 300 m.

3.2.5 Permian Rangal Coal Measures

The Rangal Coal Measures (RCM) underlie the Rewan Group and outcrop to the west of the Project Area (**Figure 3-1**). This unit consists of interbedded sandstone, siltstone, mudstone, and coal with tuff (towards the base) and has a thickness of up to 100 m in the Study Area. The three main economic coal seams are the Aries, Castor and Pollux Seam. This naming convention applied regionally. For operational reasons, the coal seams follow a different naming convention at BWM: Aries Seam is referred to as the Top Seam, the Castor Seam is referred to as the Middle Seam and the Pollux Seam is referred to as the Lower Seam.

The splitting and occurrence of these seams is shown in **Figure 3-3.** The principal coal seams in the BWM area (from top to bottom) are the Top Seam (also known as TFULL), Middle Seam (MFULL) and Middle split (MB), Lower Seam (LFULL) and Lower split (L01). Minor seams include the Upper Top (UT), Top Rider (TR), Middle Rider (MR) and Lower and Upper Rider (LUR) seams.

The Pollux and Orion seams create the thick Argo seam (CD) in the southern South Blackwater Mine area. To the north, the Orion and Pollux Seams coalesce into the Lower (LFULL) Seam. This seam splits into the lower split (L01) and the Middle seam (MFULL). Between the Deep Creek/Wilpeena and Blackwater pit areas the Middle Seam coalesces with the Aries and Castor Seams.

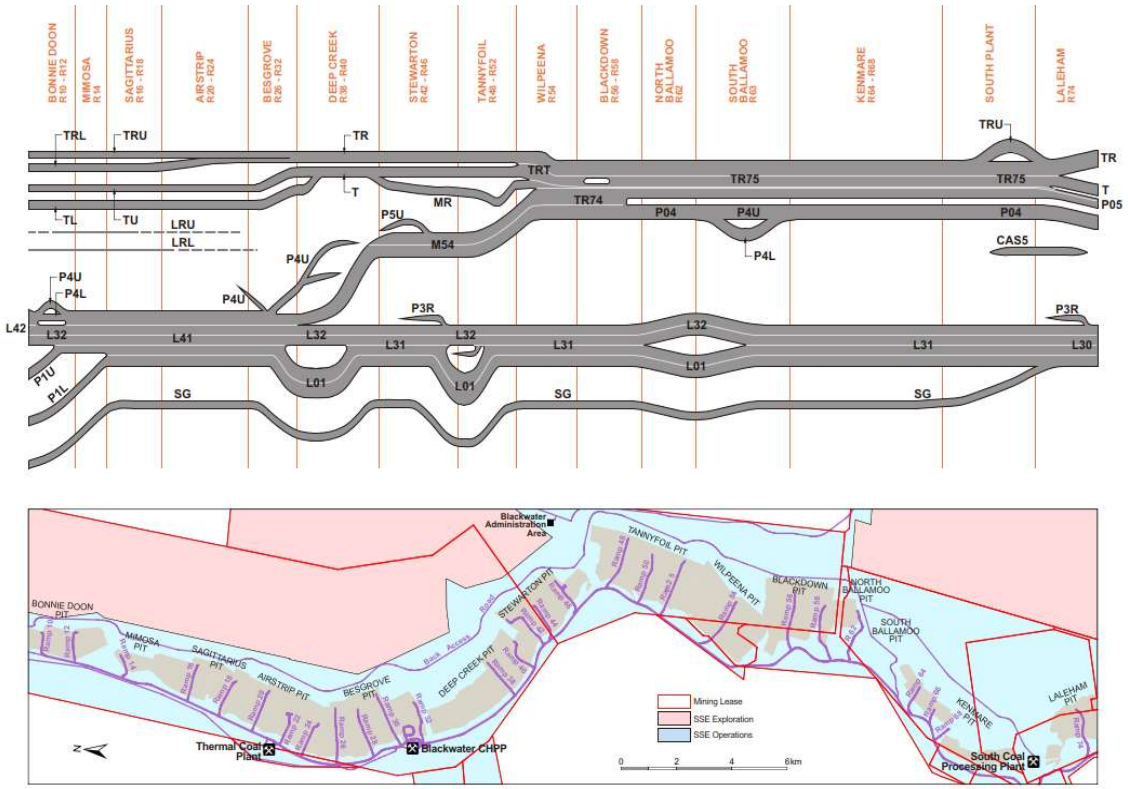


Figure 3-3 Schematic Seam Stratigraphy and Split Diagram (BMA, 2014)

3.2.6 Burngrove Formation

The Burngrove Formation is comprised of mudstone, siltstone, sandstone, coal and tuff. The RCM conformably overlie the coal bearing Burngrove Formation. The Burngrove Formation is equivalent to the Fort Cooper Coal Measures elsewhere in the Bowen Basin and is considered the basement formation for this assessment.

4.0 Hydrogeology

This section discusses each of the hydrogeological units relevant to the Project, describing groundwater hydrology (groundwater occurrence, hydraulic gradients, recharge and discharge), hydraulic properties, groundwater quality, and groundwater use and management. The conceptual hydrogeological model for the Study Area, refined with the most recent groundwater monitoring dataset with a focus on the Project, is summarised in **Section 6.1**.

The local hydrostratigraphic units are described below, from the shallowest (Alluvium) to the deepest (Burngrove Formation):

- **Alluvium** - Alluvial deposits are associated with local creeks. In recent years, the alluvium local to the Study Area has been found dry.
- **Tertiary Sediments and Basalt** - Unconsolidated surface layer of weathered rock (also referred to as regolith) which may provide a preferential flow pathway for groundwater if levels exceed the base of weathering.
- **Clematis Group** - outcrops on the eastern margins of the Study Area, where it forms an elevated plateau. The unit is comprised of weathering resistant medium to coarse grained quartzose to sublabile and micaceous sandstone, siltstone, mudstone and conglomerate.
- **Rewan Group** - A regional scale aquitard comprising mudstones interbedded with siltstone and fine to medium grained labile sandstone. However, permeability testing indicates hydraulic conductivity values may be higher in the upper weathered zone of the unit.
- **Rangal Coal Measures (RCM)** - Previous investigations (EMM, 2020) identified this formation as a regional aquifer. Groundwater flow is primarily within the coal seams (via interconnected cleats and fractures), which are confined by low permeability overburden and interburden that essentially form aquitards. The coal measures are highly faulted resulting in “compartmentalisation” with coal seams juxtaposed against lower permeability interburden. Recharge to this unit occurs via direct infiltration where the unit outcrops or sub-crops.
- **Burngrove Formation** - outcrops to the west of BWM and dips east below the Rangal Coal Measures. It is largely regarded an aquitard comprising interbedded siltstone, carbonaceous and tuffaceous shales, mudstone, and thin coal seams. However, several landholder bores are apparently screened within this formation locally (assuming the registered bore database aquifer attribution is correct) suggesting it includes permeable horizons that can support low yields. This formation is considered the basement for the purposes of this assessment.

4.1 BWM Groundwater Monitoring

Figure 4-1 to **Figure 4-8** and **Table 4-1** to **Table 4-8** show the BWM groundwater monitoring network bores for which data is available for this assessment. Data used for this assessment has been collected from 144 monitoring bores and four Vibrating Wire Piezometers (VWPs). The period for which groundwater quality and groundwater level data is available from these bores is also listed in the tables below.

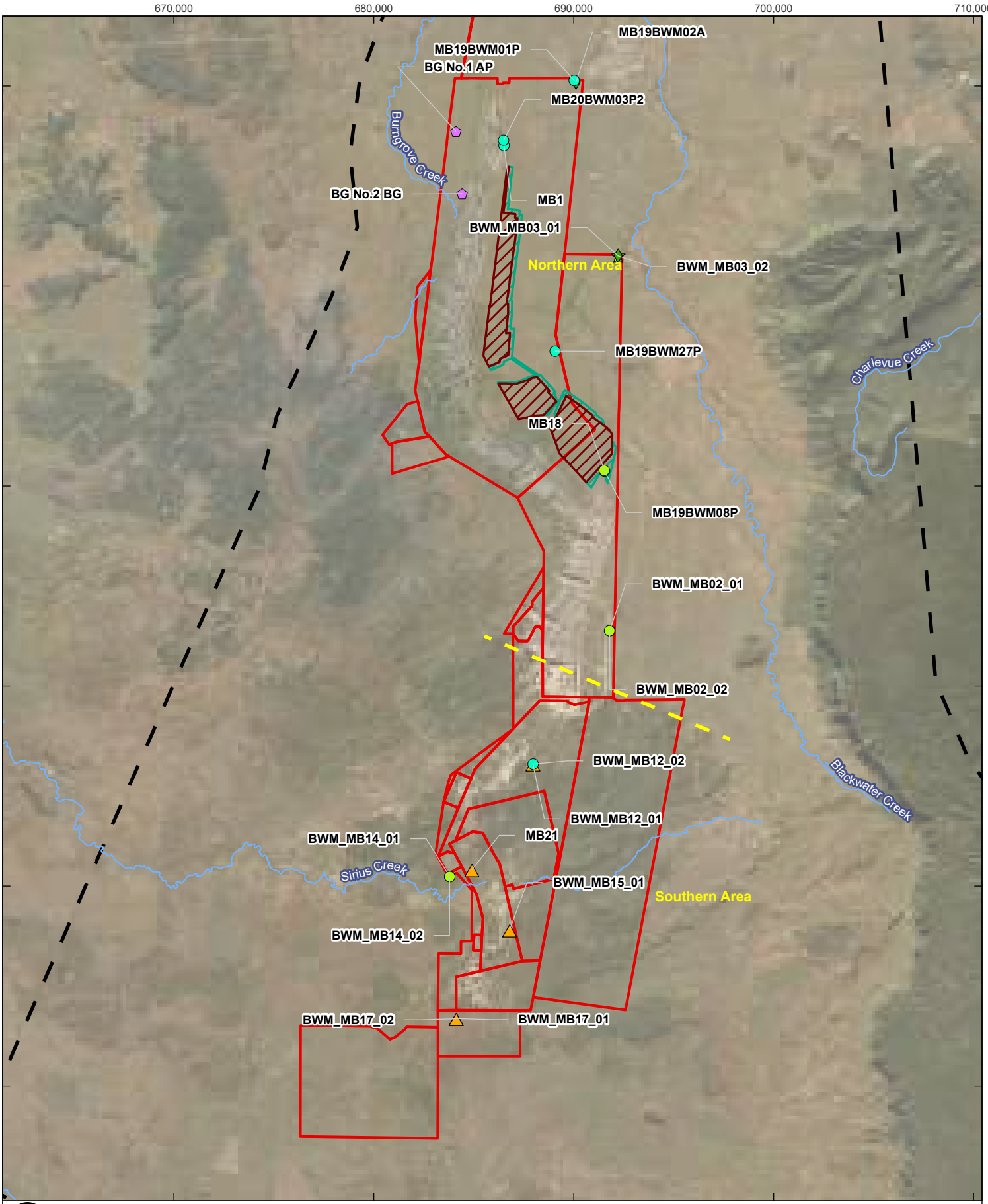
4.1.1 BWM EA Monitoring Bores

There is a total of 21 EA monitoring bores across BWM. Details of these bores are shown in **Table 4-1** with their locality shown in **Figure 4-1**.

Table 4-1 EA Monitoring Bores

Bore	Easting[1]	Northing[1]	TOC (mAHD)	Depth (mBGL)	Screened Interval (mBGL)	Monitored Unit	BWM Area	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
BWM_MB03_01	692223	7381510	181.98	12	8 - 11	Alluvium	BWM South	Active (dry)	26/11/2024	26/11/2024	-	-
BWM_MB12_01	687961	7356102	332.79	24	16-22	Tertiary	BWM South	Active (dry)	30/05/2022	30/01/2025	-	-
BWM_MB15_01	686794	7347807	321.39	16.43	10.43 - 16.43	Tertiary	BWM South	Active	22/05/2022	4/03/2025	23/08/2023	4/03/2025
BWM_MB17_01	684127	7343376	262.29	18	12 - 18	Tertiary Basalt	BWM South	Active (dry)	22/08/2022	4/03/2025	-	-
BWM_MB17_02	684119	7343373	262.38	29	22 - 28	Tertiary	BWM South	Active	22/08/2022	4/03/2025	25/08/2023	4/03/2025
MB21	684905	7350813	264.23	31	25 - 31	Tertiary Sediments	BWM South	Active	31/08/2009	4/03/2025	31/08/2009	4/03/2025
MB19BWM02A	690112	7390183	168.87	15	12 - 15	Weathered Rewan	BWM North	Active	17/12/2019	5/03/2025	30/06/2020	5/03/2025
BWM_MB03_02	692220	7381519	182.13	42	35 - 41	Rewan	BWM South	Active	21/08/2023	26/11/2024	21/08/2023	8/03/2025
BWM_MB02_01	691791	7362760	259.73	28.4	22.3 - 28.3	RCM (OB)	BWM North	Active	16/08/2023	28/01/2025	16/08/2023	8/03/2025
MB18	691528	7370782	221.41	40.6	37.6 - 40.6	RCM (Sandstone OB)	BWM North	Active	1/09/2009	8/03/2025	1/09/2009	8/03/2025
BWM_MB14_01	683797	7350477	267.75	25	18 - 24	RCM (IB)	BWM South	Active	28/01/2023	4/03/2025	14/06/2022	4/03/2025
BWM_MB14_02	683798	7350466	267.74	152	144 - 150	RCM (Sandstone OB)	BWM South	Active	21/04/2022	4/03/2025	14/06/2022	4/03/2025
MB1	686514	7387022	201.16	60	54 - 60	RCM (Aries)	BWM North	Active	1/09/2009	3/03/2025	1/09/2009	3/03/2025
MB19BWM01P	690024	7390277	168.58	171	168 - 171	RCM (Aries)	BWM North	Active	17/12/2019	26/11/2024	15/06/2020	26/11/2024
MB19BWM27P	689070	7376739	197.35	189	180 - 189	RCM (Aries & siltstone)	BWM North	Active	19/12/2019	6/03/2025	30/06/2020	6/03/2025
MB20BWM03P2	686490	7387289	199.62	109	98 - 107	(RCM, Castor and Pollux)	BWM North	Active	25/02/2021	3/03/2025	10/02/2021	3/03/2025
BWM_MB02_02	691803	7362756	259.85	153.5	144 - 150	RCM (Castor)	BWM North	Active	16/08/2023	31/01/2025	29/09/2020	8/03/2025
MB19BWM08P	691544	7370740	221.67	190	184 - 190	RCM (Aries Seam & Siltstone)	BWM North	Active	29/06/2020	25/11/2024	30/06/2020	8/03/2025
BWM_MB12_02	687969	7356097	333.56	159	155 - 158	RCM (Castor)	BWM South	Active	30/05/2022	30/01/2025	17/08/2023	8/03/2025
BG No.1 AP	684107	7387742	200.46	72.9	63.6 - 72.9	Burngrove	BWM North	Active	19/01/2012	5/03/2025	28/12/2011	5/03/2025
BG No.2 BG	684414	7384622	211.79	38.5	32.3 - 38.5	Burngrove	BWM North	Active	19/01/2012	5/03/2025	28/12/2011	5/03/2025

O/I = overburden/interburden
1 Coordinates GDA 2020 Zone 55



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	06-May-2026
Drawn by:	RB

LEGEND

Groundwater Monitoring Location

- Alluvium
- Tertiary
- Rewan
- RCM (Coal)
- RCM Overburden/Interburden
- Burngrove

- Watercourse
- Area
- BWM Mining Lease
- GIA Study Area
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER MONITORING NETWORK- BWM EA BORES

SLR

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FIGURE 4-1

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F04_1_Groundwater Monitoring Network (BWM EA Bores)

4.1.2 BWM Non EA Monitoring Bores

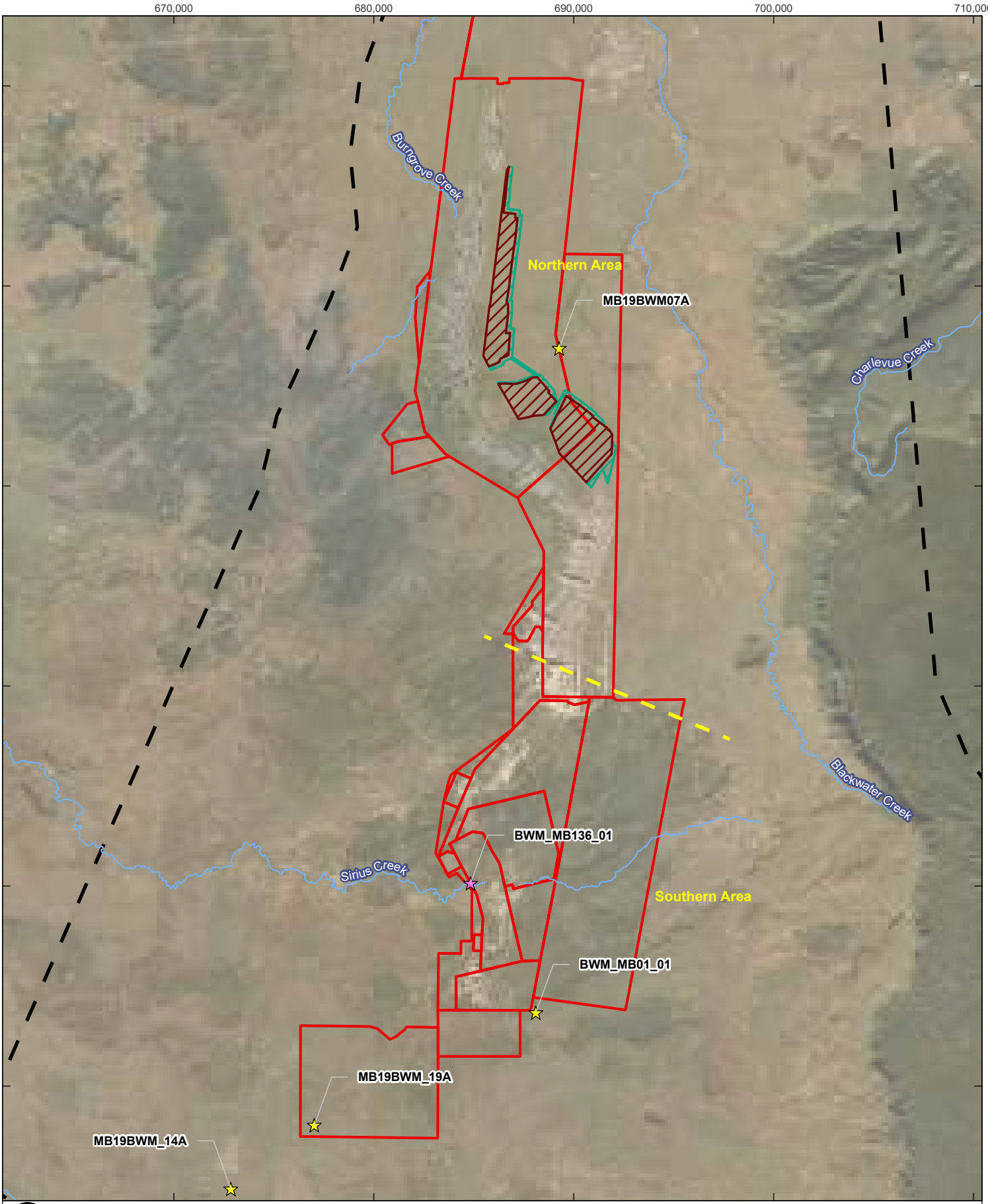
4.1.2.1 Quaternary Sediments

The BWM groundwater monitoring network for the alluvium is shown in **Table 4-2** and **Figure 4-2**. The monitoring network comprises a total of six monitoring bores (one of which is a current EA bore and thus is not presented here but in **Section 4.1.1**), installed at depths ranging from 7 to 16 mBGL, with available data between 2019 and 2025. All excluding one, which was located to the south of the BWM operations, are observed to be dry.

Table 4-2 Quaternary Sediments Groundwater Monitoring Network

Bore	Easting[1]	Northing[1]	TOC (mAHD)	Depth (mBGL)	Screened Interval (mBGL)	Monitored Unit	BWM Area	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
MB19BWM07A	689271	7376875	196.5	7	4 - 7	Alluvium	BWM North	Active (dry)	18/12/2019	22/06/2023	30/06/2020	22/06/2023
BWM_MB01_01	688102	7343664	271.04	16	10 - 16	Alluvium	BWM South	Active	17/03/2023	20/11/2024	17/03/2023	20/07/2023
MB19BWM_14A	672849	7334846	205.84	7.5	6 - 7	Alluvium	BWM South	Active (dry)	4/08/2022	27/06/2023	-	-
MB19BWM_19A	677022	7338038	224.72	14.5	9 - 12	Alluvium	BWM South	Active (dry)	4/08/2022	27/06/2023	-	-
BWM_MB136_01	684837	7350128	256.26	8.3	4.0 - 7.0	Alluvium/ Burngrove	BWM South	Active (dry)	18/10/2024	31/01/2025	-	-

1 Coordinates GDA 2020 Zone 55



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	06-May-2026
Drawn by:	AS

LEGEND

Groundwater Monitoring Location

- Alluvium
- Alluvium/ Burngrove
- Watercourse
- Area
- BWM Mining Lease
- GIA Study Area
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER MONITORING NETWORK- QUATERNARY SEDIMENTS

SLR

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FIGURE 4-2

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F04_2_Groundwater Monitoring Network (Quaternary Sediments)

4.1.2.2 Tertiary Sediments and Basalt

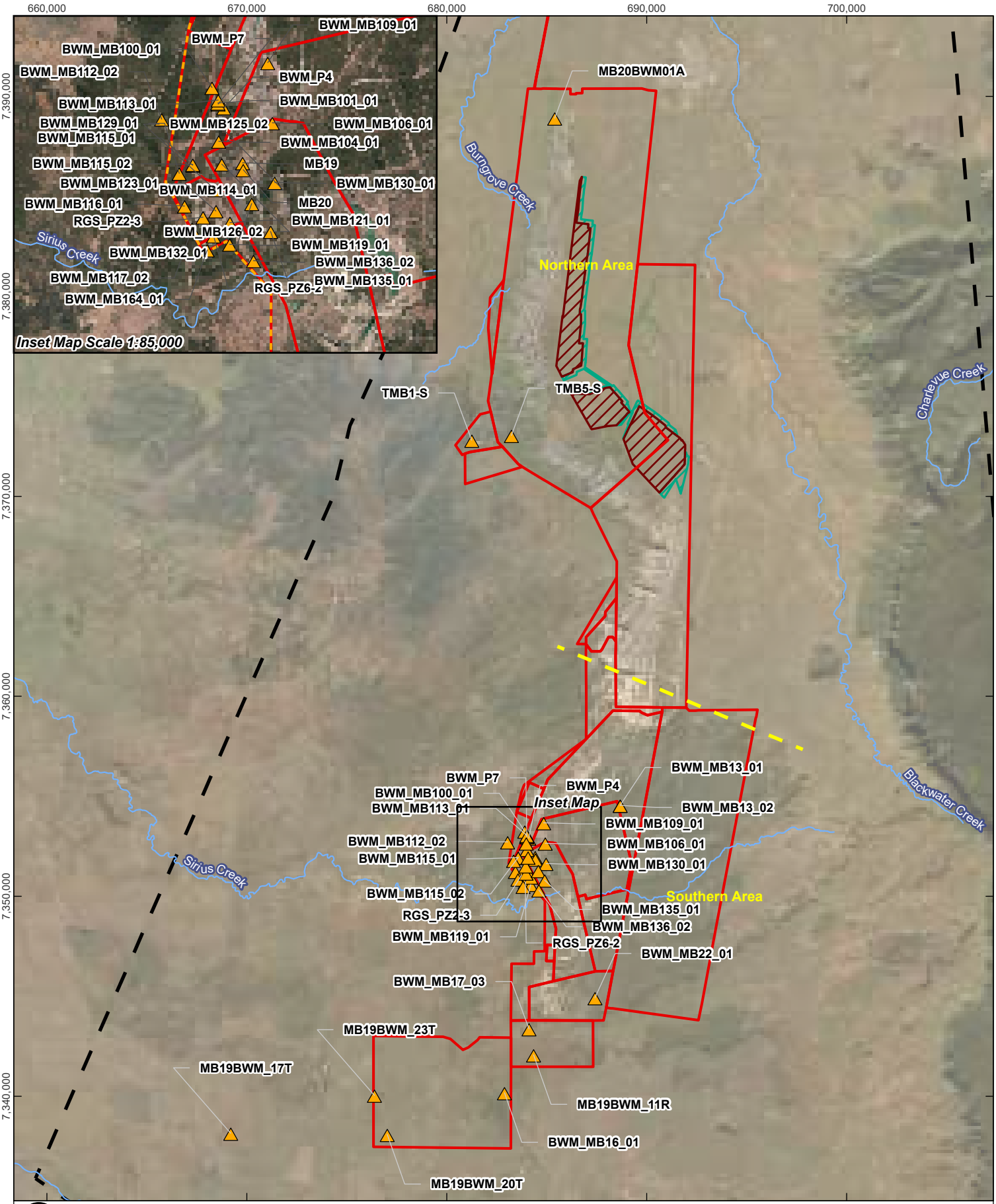
The BWM non-EA groundwater monitoring network for the Tertiary Sediments and Basalt is shown in **Table 4-3** and **Figure 4-3**. This network includes 47 monitoring bores (five of which are current EA bores and thus not presented here but in **Section 4.1.1**), installed at depths from 4.5 to 56 mBGL, with available data between 2009 and 2025. Of these, 24 bores are currently dry.

Table 4-3 Tertiary Sediments and Basalt Groundwater Monitoring Network

Bore	Easting[1]	Northing[1]	TOC (mAHD)	Depth (mBGL)	Screened Interval (mBGL)	Monitored Unit	BWM Area	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
MB20BWM01A	685396	7388908	187.76	9.5	6.5 - 9.5	Tertiary	BWM North	Active	21/06/2023	30/01/2025	-	-
TMB5-S	683230	7373039	239.06	15	12 - 15	Tertiary	BWM North	Active	17/01/2024	27/11/2024	27/11/2024	27/11/2024
TMB1-S	681249	7372800	259.53	16	13 - 16	Tertiary	BWM North	Active	18/01/2024	29/11/2024	29/11/2024	29/11/2024
BWM_MB13_01	688667	7354548	301.14	4.5	2.5 - 4.5	Tertiary	BWM South	Active (dry)	23/08/2022	29/01/2025	-	-
BWM_MB13_02	688672	7354546	300.53*	22	16 - 22	Tertiary	BWM South	Active (dry)	21/08/2022	29/01/2025	-	-
BWM_MB16_01	682882	7340174	283.63	56	49 - 55	Tertiary	BWM South	Active	19/08/2022	20/11/2024	-	-
BWM_MB17_03	684111	7343371	262.46	46	40 - 46	Tertiary	BWM South	Active	22/08/2022	25/09/2024	-	-
BWM_MB22_01	687412	7344924	286.17	26.5	21 - 26.5	Basalt	BWM South	Active	17/03/2023	20/11/2024	17/03/2023	17/03/2023
BWM_P4	684098	7352908	284.44	15.5	12.5 - 15.5	Tertiary (clay)	BWM South	Active	26/01/2023	10/09/2024	26/01/2023	28/09/2023
BWM_P7	684002	7352973	284.95	15.5	12.4 - 15.4	Tertiary (clay)	BWM South	Active	26/01/2023	10/09/2024	26/01/2023	28/09/2023
MB19	684418	7351975	310.7	19.7	13.7 - 19.7	Tertiary	BWM South	Unknown	31/08/2009	31/01/2025	31/08/2009	30/05/2012
MB19BWM_11R	684338	7342067	290.92	41.4	35.43 - 41.43	Tertiary (Basalt)	BWM South	Active (dry)	2/02/2023	27/06/2023	-	-
MB19BWM_17T	669191	7338149	226.31	32.5	26 - 32	Tertiary	BWM South	Active (dry)	6/11/2022	27/06/2023	-	-
MB19BWM_20T	677019	7338087	224.5	30.5	24 - 30	Tertiary (Sandstone with minor basalt)	BWM South	Active (dry)	20/09/2022	27/06/2023	-	-
MB19BWM_23T	676379	7340051	238.87	43.5	36.26 - 42.26	Tertiary	BWM South	Active (dry)	19/08/2022	27/06/2023	-	-
MB19BWM_26A	683558	7333194	226.86	15.5	9 - 15	Tertiary	BWM South	Active	26/05/2022	20/11/2024	-	-
MB20	684428	7351856	311.58	31.6	25.6 - 31.6	Tertiary	BWM South	Active (dry)	20/10/2009	31/01/2025	27/07/2009	11/02/2021
RGS_PZ2-3	683745	7351052	285.56	10.5	6 - 10.5	Tertiary	BWM South	Active	29/01/2023	11/06/2024	29/01/2023	26/09/2023
RGS_PZ6-2	683925	7350731	276.64	6.5	3.5 - 6.5	Tertiary Clays (fractured zone)	BWM South	Active	30/01/2023	12/06/2024	30/01/2023	29/09/2023
BWM_MB100_01	683897	7353255	304.36	17.5	10.5 - 16.5	Tertiary	BWM South	Active (dry)	23/08/2022	15/10/2024	-	-
BWM_MB101_01	683996	7352990	285	28	19 - 28	Tertiary (Clays, weathered sandstone)	BWM South	Active (dry)	15/10/2024	15/10/2024	-	-
BWM_MB104_01	684011	7352341	309.2	20	13.5 - 19.5	Tertiary	BWM South	Active (dry)	15/10/2024	15/10/2024	-	-
BWM_MB106_01	684923	7352654	307.81	32.5	26 - 32	Tertiary	BWM South	Active	15/10/2024	15/10/2024	-	-
BWM_MB109_01	684845	7353676	316.31	36	29.5 - 35.5	Tertiary	BWM South	Active (dry)	22/10/2024	22/10/2024	-	-
BWM_MB112_02	683041	7352718	269.92	21.4	15 - 21	Tertiary	BWM South	Active (dry)	15/10/2024	15/10/2024	-	-
BWM_MB113_01	684003	7353042	285.51	13.5	7 - 10	Tertiary	BWM South	Active	15/10/2024	15/10/2024	-	-
BWM_MB114_01	683973	7352659	295.95	20.4	12.3 - 16.3	Tertiary	BWM South	Active	15/10/2024	15/10/2024	-	-
BWM_MB115_01	683572	7351933	310.44	12	8.5 - 11.5	Tertiary	BWM South	Active (dry)	15/10/2024	15/10/2024	-	-
BWM_MB115_02	683570	7351947	310.48	25.3	18.5 - 24.5	Tertiary	BWM South	Active (dry)	15/10/2024	15/10/2024	-	-
BWM_MB116_01	683431	7351240	304.83	12.9	9.4 - 12.4	Tertiary	BWM South	Active (dry)	16/10/2024	16/10/2024	-	-
BWM_MB117_02	683557	7350857	302.84	29.5	21.9 - 27.9	Tertiary	BWM South	Active	16/10/2024	16/10/2024	-	-
BWM_MB119_01	684198	7350590	281.36	19	15.5 - 18.5	Tertiary	BWM South	Active (dry)	16/10/2024	16/10/2024	-	-
BWM_MB121_01	684202	7350959	307.11	18.5	10.5 - 16.5	Tertiary	BWM South	Active (dry)	16/10/2024	16/10/2024	-	-
BWM_MB123_01	683965	7351157	307.03	8.8	5.2 - 8.2	Tertiary	BWM South	Active (dry)	16/10/2024	16/10/2024	-	-
BWM_MB125_02	683948	7351517	307.97	42.5	36 - 42	Tertiary	BWM South	Active (dry)	16/10/2024	16/10/2024	-	-
BWM_MB126_02	684063	7351953	312.14	32.5	26 - 32	Tertiary	BWM South	Active	8/11/2024	8/11/2024	-	-

Bore	Easting[1]	Northing[1]	TOC (mAHD)	Depth (mBGL)	Screened Interval (mBGL)	Monitored Unit	BWM Area	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
BWM_MB129_01	683340	7351795	306.52	20.4	14 - 20	Tertiary	BWM South	Active (dry)	5/11/2024	5/11/2024	-	-
BWM_MB130_01	684963	7351640	281.62	18	14.0 - 17.0	Tertiary into RCM OB	BWM South	Active	22/10/2024	22/10/2024	-	-
BWM_MB132_01	684573	7351281	288.66	19	12.5 - 18.5	Tertiary	BWM South	Active (dry)	22/10/2024	22/10/2024	-	-
BWM_MB135_01	684895	7350808	263.75	12	6.5 - 9.5	Tertiary	BWM South	Active (dry)	18/10/2024	18/10/2024	-	-
BWM_MB136_02	684603	7350311	255.41	21.5	15.0 - 21.0	Tertiary	BWM South	Active	18/10/2024	18/10/2024	-	-
BWM_MB164_01	683816	7350493	269.25	15.3	8.5 - 14.5	Tertiary (Silty clay)	BWM South	Active	16/10/2024	16/10/2024	-	-

O/I = overburden/interburden
1 Coordinates GDA 2020 Zone 55
* Ground Level


660,000
670,000
680,000
690,000
700,000
7,390,000
7,380,000
7,370,000
7,360,000
7,350,000
7,340,000
BWM_MB109_01
BWM_P7
BWM_MB100_01
BWM_MB112_02
BWM_P4
BWM_MB113_01
BWM_MB101_01
BWM_MB129_01
BWM_MB125_02
BWM_MB106_01
BWM_MB115_01
BWM_MB104_01
BWM_MB115_02
MB19
BWM_MB123_01
BWM_MB114_01
BWM_MB130_01
BWM_MB116_01
MB20
RGS_PZ2-3
BWM_MB121_01
BWM_MB126_02
Sirius Creek
BWM_MB119_01
BWM_MB132_01
BWM_MB136_02
BWM_MB117_02
BWM_MB135_01
RGS_PZ6-2
BWM_MB164_01
Inset Map Scale 1:85,000
MB20BWM01A
Burngrove Creek
Northern Area
TMB1-S
TMB5-S
Charlevue Creek
BWM_MB13_01
BWM_P7
BWM_P4
BWM_MB100_01
Inset Map
BWM_MB13_02
BWM_MB113_01
BWM_MB109_01
BWM_MB112_02
BWM_MB106_01
BWM_MB115_01
BWM_MB130_01
Sirius Creek
Southern Area
BWM_MB115_02
BWM_MB135_01
RGS_PZ2-3
BWM_MB136_02
BWM_MB119_01
RGS_PZ6-2
BWM_MB22_01
BWM_MB17_03
MB19BWM_23T
MB19BWM_17T
MB19BWM_11R
BWM_MB16_01
MB19BWM_20T
Blackwater Creek
0
2.5
5
km
LEGEND
Groundwater Monitoring Location
Tertiary
Watercourse
Area
BWM Mining Lease
GIA Study Area
Proposed Open Cut Extension
Proposed Infrastructure Area
Coordinate System: GDA2020 MGA Zone 55
Scale: 1:250,000 at A4
Project Number: 620.040199
Date Drawn: 06-May-2026
Drawn by: AS
BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT
GROUNDWATER MONITORING NETWORK- TERTIARY
SLR
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FIGURE 4-3
Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F04_3_Groundwater Monitoring Network (Tertiary)

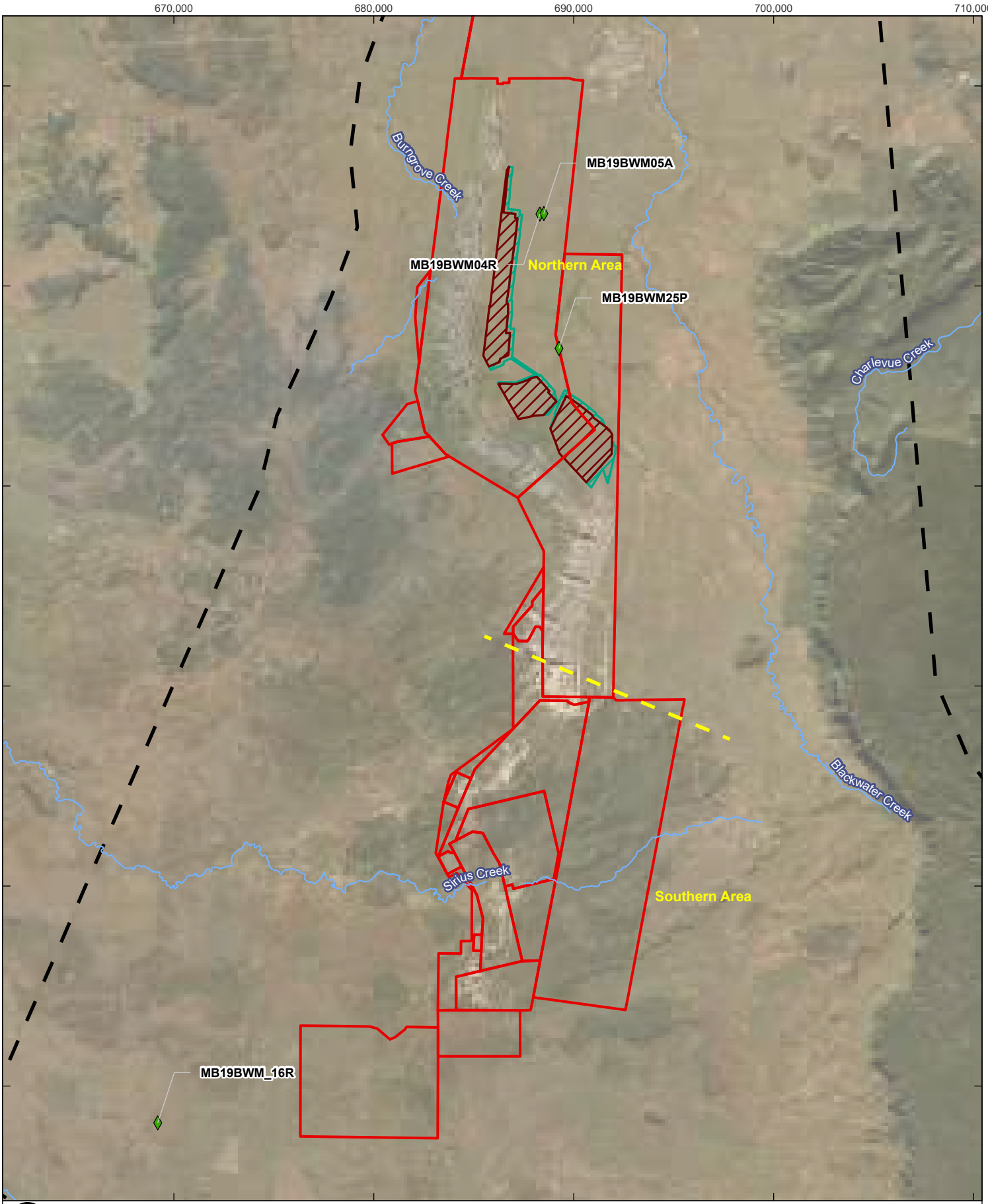
4.1.2.3 Triassic Rewan Group

The BWM non-EA groundwater monitoring network for the Triassic Rewan Group includes a total of six monitoring bores (two of which are current EA bores, thus not presented here but in **Section 4.1.1**). Bores are installed at depths ranging from 15 to 95 mBGL, with available data between 2023 and 2025. Bore details and their locality are shown in **Table 4-4** and **Figure 4-4** respectively.

Table 4-4 Triassic Rewan Group Groundwater Monitoring Network

Bore	Easting[1]	Northing[1]	TOC (mAHD)	Depth (mBGL)	Screened Interval (mBGL)	Monitored Unit	BWM Area	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
MB19BWM04R	688307	7383595	200.9	80	71 - 80	Rewan	BWM North	Active	30/06/2020	21/06/2023	30/06/2020	26/09/2023
MB19BWM05A	688507	7383623	199.57	15	9 - 15	Weathered Rewan	BWM North	Active (dry)[2]	18/12/2019	21/06/2023	30/06/2020	21/06/2023
MB19BWM25P	689262	7376881	196.42	20	17 - 20	Rewan	BWM North	Active	1/07/2020	22/06/2023	30/06/2020	26/09/2023
MB19BWM_16R	669188	7338156	226.26	95	87 - 93	Rewan	BWM South	Active	6/11/2022	19/11/2024	31/01/2023	12/09/2023

1 Coordinates GDA 2020 Zone 55
2 bore forms part of the groundwater network and is currently monitored, however, it is currently dry



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	06-May-2026
Drawn by:	AS

LEGEND

Groundwater Monitoring Location

- Rewan

- Watercourse
- Area
- BWM Mining Lease
- GIA Study Area
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER MONITORING NETWORK- REWAN GROUP

SLR

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FIGURE 4-4

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F04_4_Groundwater Monitoring Network (Rewan Group)

4.1.2.4 Rangal Coal Measures

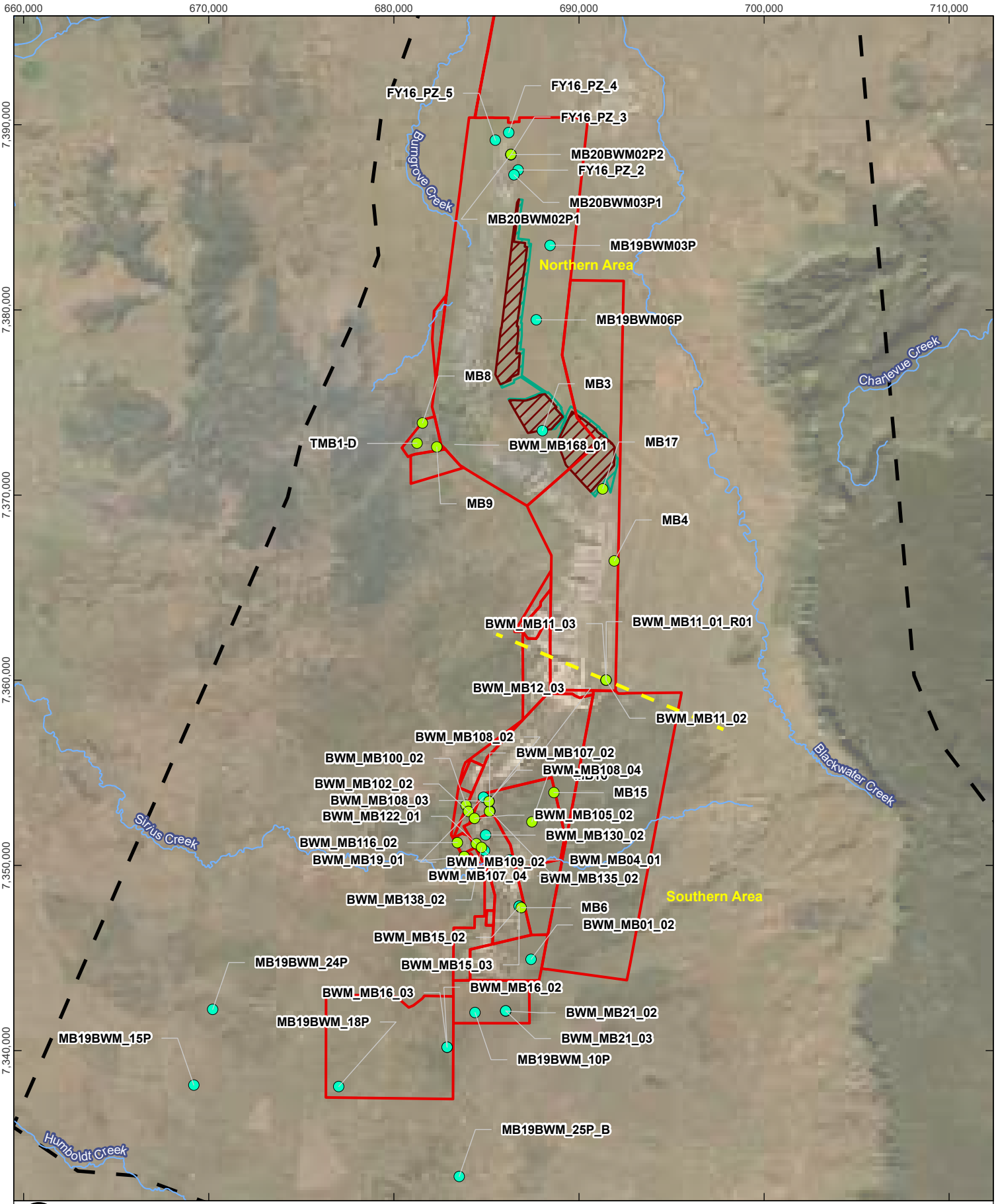
BWM non-EA groundwater monitoring bores targeting the Rangal Coal Measures are shown in **Table 4-5** and **Figure 4-5** and comprises a total of 51 monitoring bores. The bores are installed at depths ranging from 17 to 231.5 mBGL, with available data between 2009 and 2025, and six bores observed as dry.

Table 4-5 Rangal Coal Measures Groundwater Monitoring Network

Bore	Easting[1]	Northing[1]	TOC (mAHD)	Depth (mBGL)	Screened Interval (mBGL)	Monitored Unit	BWM Area	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
FY16_PZ_2	686714	7387555	200.03	104.7	100.7 - 103.7	Pollux	BWM North	Active	26/11/2020	21/06/2023	26/11/2020	27/09/2023
FY16_PZ_3	686322	7388372	193.48	82.5	72.5 - 81.5	Pollux	BWM North	Active	25/11/2020	30/01/2025	23/03/2021	21/06/2023
FY16_PZ_4	686206	7389577	191	54	50 - 53	Pollux	BWM North	Active	25/11/2020	30/01/2025	25/11/2020	27/09/2023
FY16_PZ_5	685482	7389168	186.97	53.5	49.5 - 52.5	Pollux	BWM North	Active	25/11/2020	30/01/2025	25/11/2020	27/09/2023
MB19BWM03P	688442	7383483	199.39	231.5	222.5 - 231.5	Aries & Siltstone	BWM North	Active	30/06/2020	21/06/2023	30/06/2020	26/09/2023
MB19BWM06P	687694	7379464	209.64	186	180 - 186	Siltstone & Aries	BWM North	Active	30/06/2020	21/06/2023	30/06/2020	21/06/2023
MB20BWM02P1	686325	7388395	192.86	36	30 - 36	IB (Sandstone)	BWM North	Active	24/03/2021	30/01/2025	24/03/2021	21/06/2023
MB20BWM02P2	686321	7388395	192.92	66	60 - 66	Castor	BWM North	Active	25/02/2021	30/01/2025	25/02/2021	27/09/2023
MB20BWM03P1	686489	7387296	199.44	86	80 - 86	Castor	BWM North	Active	24/03/2021	30/01/2025	10/02/2021	27/09/2023
MB3	688026	7373479	219.99	78.2	73.6 - 78.2	Aries	BWM North	Active	1/09/2009	6/11/2022	12/01/2010	15/05/2023
MB8	681544	7373895	271.76*	17	14 - 17	OB/IB?	BWM North	Unknown	1/09/2009	14/06/2024	1/09/2009	29/11/2023
MB9	682318	7372602	249.08	18	15 - 18	OB/IB?	BWM North	Active	1/09/2009	22/11/2024	1/09/2009	22/11/2024
TMB1-D	681252	7372802	259.56	36	31 - 36	IB	BWM North	Active	18/01/2024	29/11/2024	29/11/2024	29/11/2024
BWM_MB11_01_R01	691464	7360014	300.66	90.4	85 - 88	OB	BWM Central	Active	2/05/2022	22/01/2024	-	-
BWM_MB11_02	691466	7360007	300.85	115.25	112.25 -115.25	Castor	BWM Central	Active	4/05/2022	23/01/2025	23/01/2025	23/01/2025
BWM_MB11_03	691459	7360009	300.62	136.2	121.2 - 127.2	Pollux	BWM Central	Active	29/04/2022	23/01/2025	23/01/2025	23/01/2025
MB17	691280	7370333	227.2	67	-	OB (Sandstone)	BWM Central	Decommissioned	1/09/2009	26/02/2020	1/09/2009	26/02/2020
MB4	691908	7366445	250.25	49.8 (52)	Unknown	OB (Sandstone)	BWM Central	Decommissioned	31/08/2009	28/11/2019	31/08/2009	28/11/2019
BWM_MB01_02	687411	7344932	286.32	128	120 - 122	Castor	BWM South	Active	17/02/2023	20/11/2024	18/02/2023	16/08/2023
BWM_MB04_01	686247	7350296	259.3*	28.5	22 - 28	Castor	BWM South	Unknown	29/01/2023	12/06/2024	29/01/2023	28/09/2023
BWM_MB12_03	687977	7356091	334.03	180	172.72-178.28	Pollux	BWM South	Active	24/05/2022	29/01/2025	-	-
BWM_MB15_02	686779	7347804	321.21	126	114 - 120	Pollux	BWM South	Active	22/05/2022	24/01/2025	24/01/2025	24/01/2025
BWM_MB15_03	686768	7347802	320.93	84.9	78.9 - 84.9	Castor	BWM South	Active	22/05/2022	24/01/2024	24/01/2025	24/01/2025
BWM_MB16_02	682883	7340184	283.25	86	79 - 85	Castor	BWM South	Active	19/08/2022	20/11/2024	-	-
BWM_MB16_03	682875	7340188	283.29	113	106.5 - 112.5	Pollux	BWM South	Active	27/11/2022	20/11/2024	31/01/2023	12/09/2023
BWM_MB168_01	683280	7372735	241.21	26.5	20 - 26	Coal		Active	-	-	-	-
BWM_MB19_01	683803	7350482	267.87	42	34 - 40	OB	BWM South	Active	18/03/2023	24/05/2023	18/03/2023	24/05/2023
BWM_MB21_02	686043	7342140	305.08	129.4	123 - 129	Aries	BWM South	Active	6/03/2023	21/11/2024	3/03/2023	3/03/2023
BWM_MB21_03	686041	7342148	305.1	163.9	153 - 159	Pollux	BWM South	Active	6/03/2023	21/11/2024	2/03/2023	2/03/2023
MB15	688648	7353936	296.89	140	None, open borehole 51.8-140	Coal in Laleham UG area (EMM, 2021)	BWM South	Decommissioned	20/10/2009	17/08/2022	20/10/2009	18/02/2023
MB16	687458	7352353	281.51	109	None, open borehole 23.6-109	OB in Kenmare UG goaf area (EMM, 2021)	BWM South	Decommissioned	20/10/2009	6/11/2022	20/10/2009	18/02/2023
MB19BWM_10P	684383	7342058	291.38	103	96.5-102.5	Aries	BWM South	Active	28/02/2023	21/11/2024	28/02/2023	15/05/2023
MB19BWM_15P	669194	7338140	226.52	140	131.7 - 137.7	Aries	BWM South	Active	1/10/2022	11/12/2023	31/01/2023	12/09/2023
MB19BWM_18P	677019	7338061	224.57	85	78.5 - 84.5	Aries	BWM South	Active	31/07/2022	11/12/2023	1/02/2023	12/09/2023
MB19BWM_24P	670211	7342228	229.43	68.5	62 - 68	Aries	BWM South	Active	1/02/2023	19/11/2024	1/02/2023	12/09/2023
MB19BWM_25P_B	683532	7333206	227	133.5	127 - 133	Aries	BWM South	Active	11/06/2022	12/12/2023	31/01/2023	7/09/2023

Bore	Easting[1]	Northing[1]	TOC (mAHD)	Depth (mBGL)	Screened Interval (mBGL)	Monitored Unit	BWM Area	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
MB6	686881	7347723	320.21	19.36 (49.7)	12.6 - 26.5	OB	BWM South	Unknown	31/08/2009	6/11/2022	31/08/2009	6/11/2022
BWM_MB122_01	684453	7351176	317.52	39.5	35 - 38	OB	BWM South	Active	22/10/2024	22/10/2024	-	-
BWM_MB130_02	684959	7351646	281.68	29.5	23.0 - 29.0	Pollux	BWM South	Active	22/10/2024	22/10/2024	-	-
BWM_MB135_02	684899	7350805	263.92	33	17.0 - 23.0	Aries	BWM South	Active	18/10/2024	18/10/2024	-	-
BWM_MB138_02	684736	7350972	276.26	26	19.5 - 25.5	IB	BWM South	Active	19/10/2024	19/10/2024	-	-
BWM_MB100_02	683897	7353250	304.38	38.5	31.5 - 37.5	IB	BWM South	Active (dry)	15/10/2024	15/10/2024	-	-
BWM_MB102_02	684026	7352919	284.31	46	39 - 45	IB	BWM South	Active (dry)	15/10/2024	15/10/2024	-	-
BWM_MB105_02	684356	7352543	308.04	20.4	14 - 20	Weathered OB	BWM South	Active (dry)	15/10/2024	15/10/2024	-	-
BWM_MB107_02	685169	7352920	314.82	34.5	29.5 - 32.5	Weathered OB	BWM South	Active (dry)	20/10/2024	20/10/2024	-	-
BWM_MB107_04	685192	7352941	315.81	87	80.5 - 86.5	Weathered RCM (Pollux 32/31/L01 seam)	BWM South	Active	20/10/2024	20/10/2024	-	-
BWM_MB108_02	685140	7353456	314.71	33	27 - 33	Weathered OB	BWM South	Active (dry)	20/10/2024	20/10/2024	-	-
BWM_MB108_03	685137	7353463	314.67	59.5	47.35 - 59.35	Aries	BWM South	Active (dry)	20/10/2024	20/10/2024	-	-
BWM_MB108_04	685132	7353470	314.72	89	80 - 86	Pollux	BWM South	Active	20/10/2024	20/10/2024	-	-
BWM_MB109_02	684843	7353684	316.18	77	65 - 71	Pollux	BWM South	Active	22/10/2024	22/10/2024	-	-
BWM_MB116_02	683430	7351232	304.88	24.5	18.8 - 22.8	Weathered OB	BWM South	Active	16/10/2024	16/10/2024	-	-

O/I = overburden/interburden
1 Coordinates GDA 2020 Zone 55
* Ground Level



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:270,000 at A4
Project Number:	620.040199
Date Drawn:	06-May-2026
Drawn by:	AS

LEGEND

Groundwater Monitoring Location

- RCM (Coal)
- RCM Overburden/Interburden

- Watercourse
- Area
- BWM Mining Lease
- GIA Study Area
- Proposed Infrastructure Area
- Proposed Open Cut Extension

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER MONITORING NETWORK- RANGAL COAL MEASURES

SLR

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FIGURE 4-5

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F04_5_Groundwater Monitoring Network (Rangal Coal Measures)

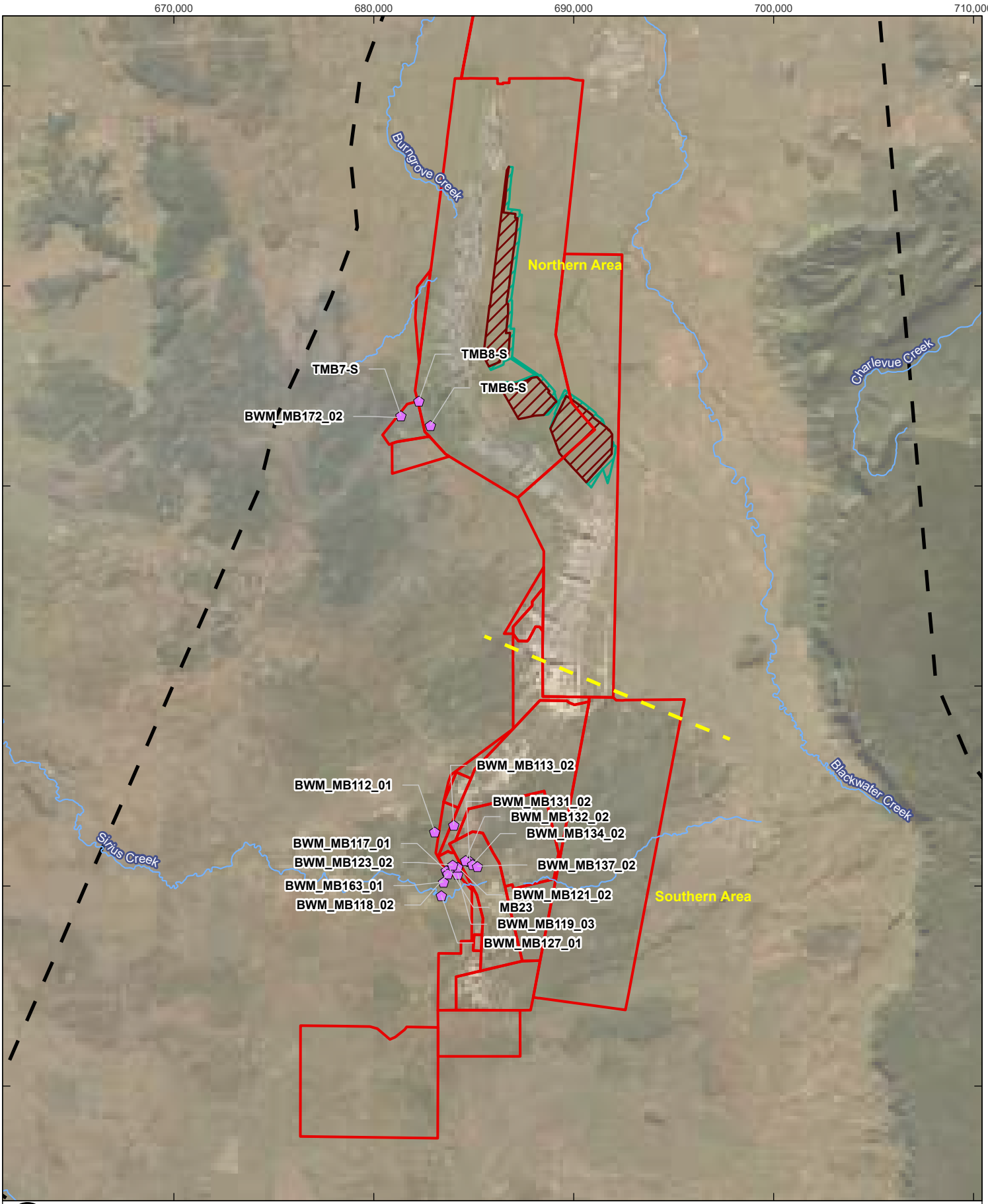
4.1.2.5 Burngrove Formation

The BWM non-EA groundwater monitoring network for the Burngrove Formation is shown in **Table 4-6** and **Figure 4-6**. The network consists of a total of 18 monitoring bores. The bores are installed at depths ranging from 8 to 72.9 mBGL, with available data between 2012 and 2025, with five observed as dry.

Table 4-6 Burngrove Groundwater Monitoring Network

Bore	Easting[1]	Northing[1]	TOC (mAHD)	Depth (mBGL)	Screened Interval (mBGL)	Monitored Unit	BWM Area	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
BWM_MB172_02	681182.8	7373429	270.3	59.5	49.5-58.5	Burngrove	BWM North	Active	-	-	-	-
MB23	683792	7350850	278.95	24	18 - 24	Burngrove	BWM South	Active	27/01/2023	14/08/2024	27/01/2023	27/09/2023
TMB6-S	682831	7373037	242.09	10	8 - 10	Burngrove (weathered mudstone)	BWM North	Active	17/01/2024	30/11/2024	30/11/2024	30/11/2024
TMB7-S	681355	7373520	263.51	10	7 - 10	Weathered Burngrove	BWM North	Active	18/01/2024	14/06/2024	-	-
TMB8-S	682255	7374259	257.4	36	30 - 36	Burngrove	BWM North	Active	18/01/2024	27/11/2024	27/11/2024	27/11/2024
BWM_MB112_01	683043	7352714	270.06	12.5	9 - 12	Burngrove	BWM South	Active (dry)	15/10/2024	15/10/2024	-	-
BWM_MB113_02	683999	7353052	285.64	30.5	20 - 29	Burngrove (Mudstone and siltstone)	BWM South	Active (dry)	15/10/2024	15/10/2024	-	-
BWM_MB117_01	683622	7350774	302.25	39.3	32.8 - 38.8	Burngrove (sandstone)	BWM South	Active	16/10/2024	16/10/2024	-	-
BWM_MB118_02	683708	7350621	278.28	28	21.5 - 27.5	Burngrove (sandstone)	BWM South	Active	16/10/2024	16/10/2024	-	-
BWM_MB119_03	684197	7350597	281.48	29.3	25.8 - 28.8	Burngrove (sandstone)	BWM South	Active (dry)	16/10/2024	16/10/2024	-	-
BWM_MB121_02	684196	7350960	307.29	32.5	23 - 32	Burngrove (sandstone)	BWM South	Active	16/10/2024	16/10/2024	-	-
BWM_MB123_02	683946	7351056	303.87	30	23 - 29	Burngrove (sandstone)	BWM South	Active	16/10/2024	16/10/2024	-	-
BWM_MB127_01	683379	7349529	248.26	11.5	7.9 - 10.9	Burngrove (sandstone)	BWM South	Active (dry)	5/11/2024	5/11/2024	-	-
BWM_MB131_02	684803	7351242	279.25	23	14.5 - 20.5	Burngrove (sandstone)	BWM South	Active	22/10/2024	22/10/2024	-	-
BWM_MB132_02	684591	7351283	288.83	29.5	23.0 - 29.0	Burngrove (sandstone)	BWM South	Active	22/10/2024	22/10/2024	-	-
BWM_MB134_02	684943	7351085	277.8	39.5	36.0 - 39.0	Burngrove (sandstone)	BWM South	Active	22/10/2024	22/10/2024	-	-
BWM_MB137_02	685185	7350987	280.35	30	23.5 - 29.5	Burngrove	BWM South	Active	22/10/2024	22/10/2024	-	-
BWM_MB163_01	683486	7350205	257.4	8	3 - 6	Weathered Burngrove	BWM South	Active (dry)	5/11/2024	5/11/2024	-	-

O/I = overburden/interburden
1 Coordinates GDA 2020 Zone 55
* Ground Level



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	06-May-2026
Drawn by:	AS

LEGEND

Groundwater Monitoring Location

- Burngrove
- Watercourse
- Area
- BWM Mining Lease
- GIA Study Area
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER MONITORING NETWORK- BURNGROVE FORMATION

SLR

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FIGURE 4-6

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F04_6_Groundwater Monitoring Network (Burngrove Formation)

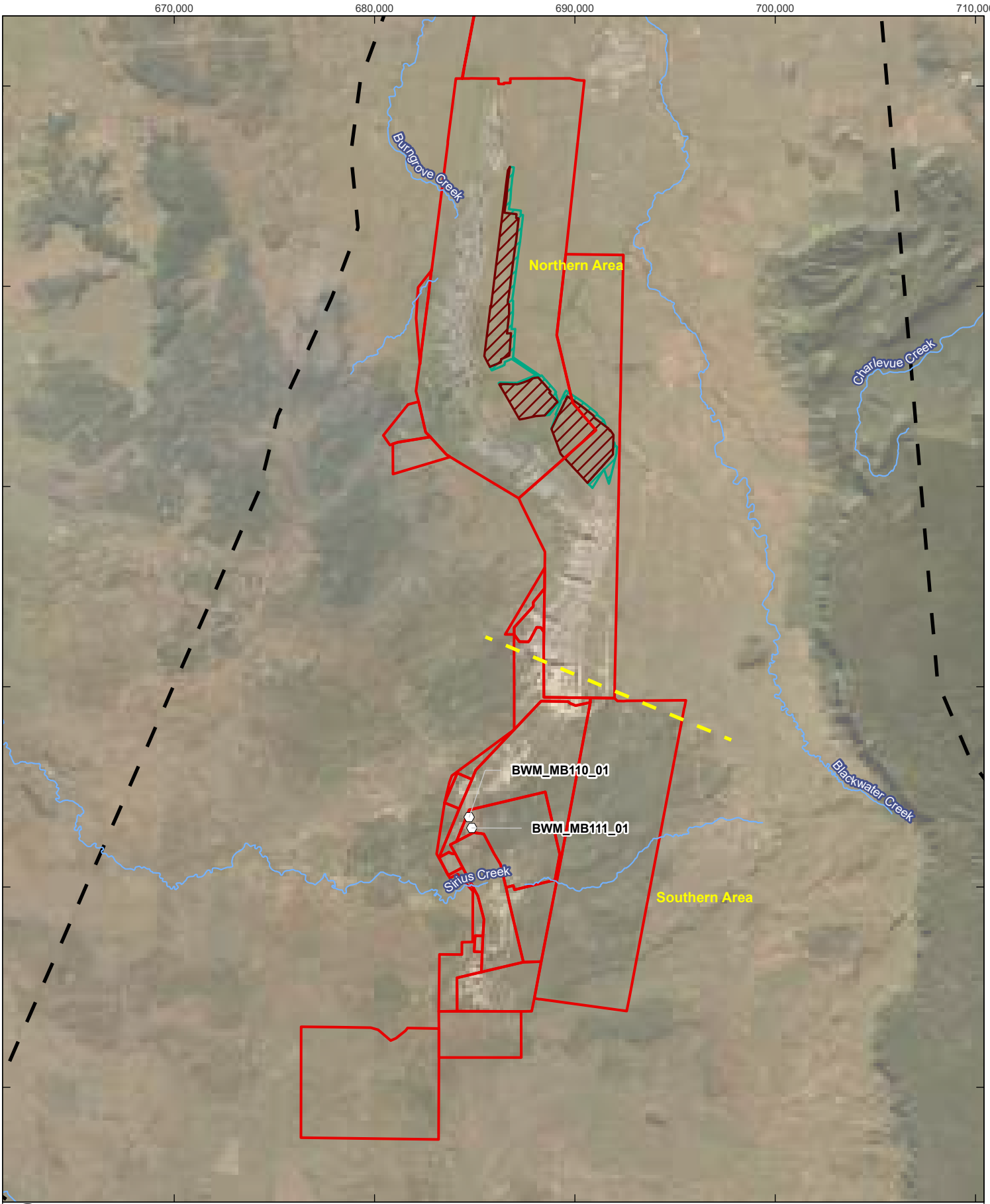
4.1.2.6 Spoil

Groundwater monitoring bores targeting spoil are shown in **Table 4-7** and **Figure 4-7** and include a total of two bores (one of which is dry), installed at depths ranging from 26 to 35.5 mBGL, with available data in 2024.

Table 4-7 Spoil Groundwater Monitoring Network

Bore	Easting[1]	Northing[1]	TOC (mAHD)	Depth (mBGL)	Screened Interval (mBGL)	Monitored Unit	BWM Area	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
BWM_MB110_01	684722	7353488	288.47	36	26 - 32	Mine spoil (tailings)	BWM South	Active	22/10/2024	22/10/2024	-	-
BWM_MB111_01	684855	7352949	304.65	39	26.5 - 35.5	Mine spoil (tailings)	BWM South	Active (dry)	22/10/2024	22/10/2024	-	-

1 Coordinates GDA 2020 Zone 55
* Ground Level



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	06-May-2026
Drawn by:	AS

LEGEND

Groundwater Monitoring Location

- Spoil
- Watercourse
- Area
- BWM Mining Lease
- GIA Study Area
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER MONITORING NETWORK- SPOIL

SLR

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FIGURE 4-7

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F04_7_Groundwater Monitoring Network (Spoil)

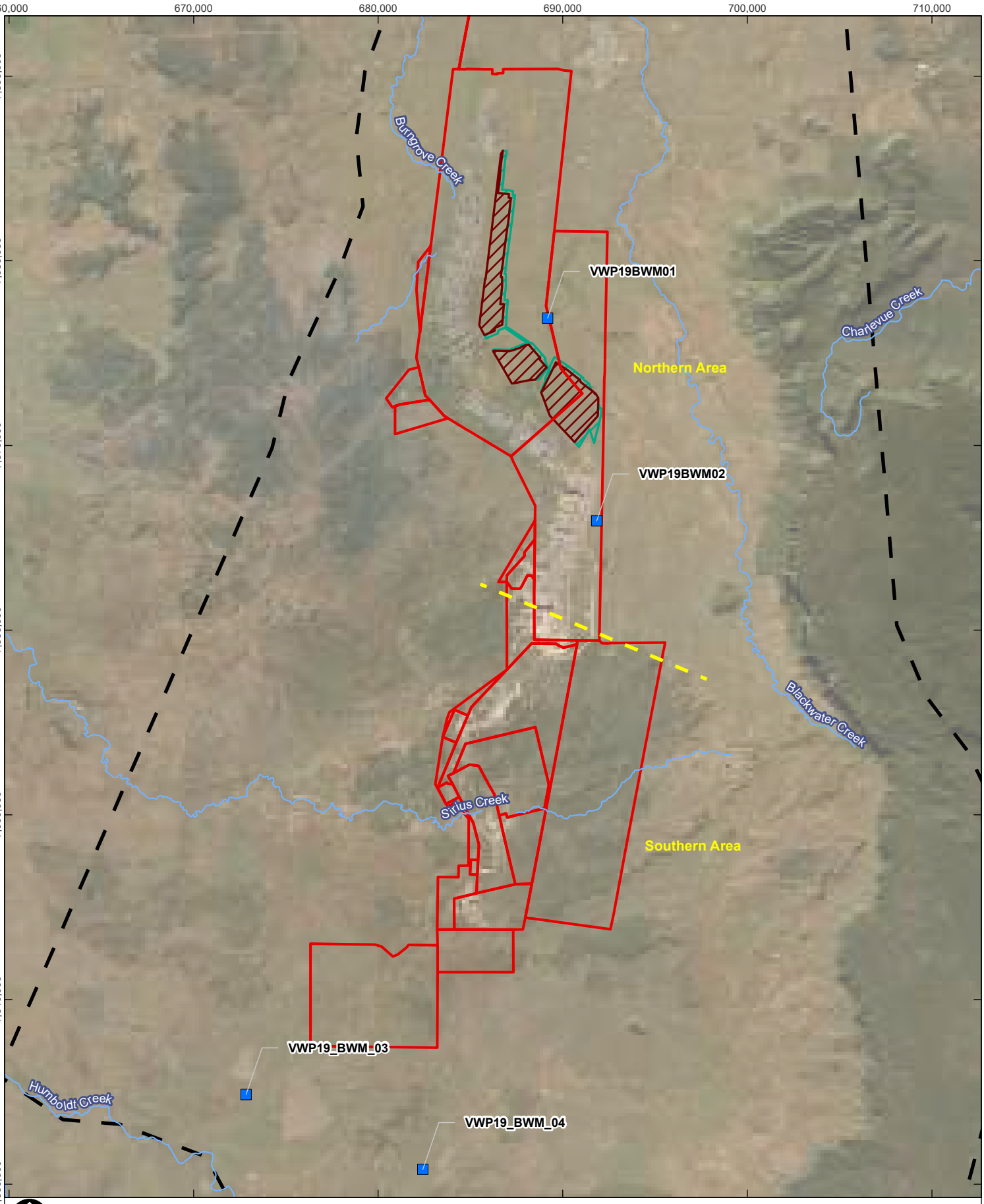
4.1.2.7 Vibrating Wire Piezometers

Four Vibrating Wire Piezometers (VWPs) are installed at BWM, two of which are located in the north and two in the south of BWM. Details for the VWPs, including sensor depths, are provided in **Table 4-8** with their locations shown in **Figure 4-8**.

Table 4-8 Vibrating Wire Piezometers

Bore	Easting[1]	Northing[1]	TOC (mAHD)	Depth (mBGL)	Sensor Depths (mBGL)	Monitored Unit	BWM Area	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
VWP19BWM01	689179	7376894	198	271.5	46 / 104 / 125 / 154 / 186	RCM OB / RCM OB / Aries / RCM IB / Pollux	BWM North	Unknown[2]	22/12/2019	22/11/2022	-	-
VWP19BWM02	691840	7365921	249	174	87.5 / 101 / 112 / 127 / 149	RCM OB / Aries / Castor / Pollux / Orion	BWM North	Unknown	22/04/2020	22/07/2022	-	-
VWP19_BWM_03	672843	7334855	206.57	190.75	40 / 100 / 155.5 / 160 / 182.5	Rewan / RCM OB / Aries / Castor / Argo	BWM South	Active	15/08/2022	15/02/2024	-	-
VWP19_BWM_04	682417	7330805	226.16	190.75	42 / 88 / 112.5 / 143.5 / 153.5	Rewan / Rewan/ Aries / Castor / Argo	BWM South	Active	15/09/2022	15/02/2024	-	-

1 Coordinates GDA 2020 Zone 55
2 status unknown as not currently monitored, and not located in recent survey and may or ma not still be in existence



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:270,000 at A4
Project Number:	620.040199
Date Drawn:	06-May-2026
Drawn by:	AS

LEGEND

Groundwater Monitoring Location

- VWP

- Watercourse
- Area
- BWM Mining Lease
- GIA Study Area
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER MONITORING NETWORK- VIBRATING WIRE PIEZOMETERS

SLR

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FIGURE 4-8

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F04_8_Groundwater Monitoring Network (Vibrating Wire Piezometers)

4.2 Hydraulic Properties

Study Area groundwater hydraulic testing includes slug (rising and falling head) tests performed on monitoring bores as well as drill stem testing. This section includes a summary of the available field hydraulic data (**Section 4.2.1**) and comparison to reported hydraulic properties within literature ranges (**Section 4.2.2**).

4.2.1 Site-Specific Hydraulic Conductivity Data

The database of available field results for horizontal hydraulic conductivity (Kh) in the Study Area is presented graphically as **Figure 4-9**. Field tests from various sources are symbolised separately on the plot.

Figure 4-9 shows that the one available test for the alluvium has an estimated hydraulic conductivity result of 0.4 m/day.

Estimated hydraulic conductivity of the Tertiary strata ranges from 0.0001 to 11.3 m/day.

Hydraulic conductivity estimates for the Rewan Group were variable, ranging from 0.0002 to a relatively high 31.6 m/day.

As shown on **Figure 4-9** the estimated hydraulic conductivity for the coal seams of the RCM are variable, ranging from 0.00003 to a spuriously high 513 m/day. It is noted that for these notably high hydraulic conductivity estimates are generally recorded in the RCM around the Red Dam area and are possibly influenced by the presence of underground mining or voids and therefore may not accurately reflect the primary hydraulic conductivity of the formation (WSP, 2024). Higher hydraulic conductivity estimates for the RCM are generally noted in the southern part of BWM, while hydraulic conductivities appear to be much lower in the north of BWM (EMM, 2021). This is supported by the more recent testing available for areas in the south of BWM conducted by AGE (2023) as shown on the figure.

Hydraulic conductivity estimates produced for the interburden of the RCM ranged from 0.00001 to 14.5 m/day. These estimates were also recorded in the RCM around the Red Dam area and hence as noted above may not be reflective of the primary hydraulic conductivity of the formation (WSP, 2024) as the hydraulic conductivity in the interburden would generally be expected to be relatively low.

Hydraulic conductivity estimates were also produced for the interburden ranging from 0.75 to 1.75 m/day resulting, from pumping tests conducted by AGC (1990) as reported in EMM (2021), however the test depth is not reported and therefore they are not included in the figure.

Estimated hydraulic conductivity recorded in the shallow Burngrove formation around the Red Dam area by WSP (2024) ranged from 0.00002 to 34.9 m/day. Again, as mentioned above notably high estimates may not be reflective of the primary hydraulic conductivity of the formation (WSP, 2024).

Estimated hydraulic conductivity for the coal seams of the Burngrove Formation were at a very low 0.000017 m/day for two tests conducted in the Virgo and Leo/Aquarius Seams.

Estimated hydraulic conductivity recorded in the Spoil around the Red Dam area by WSP (2024) ranged from 0.00003 to 7.1 m/day.

Figure 4-9 shows that the hydraulic conductivity of the RCM generally declines with depth, due to increasing overburden pressure reducing the aperture of secondary porosity features. This is typical of the Permian coal measures in the Bowen Basin (e.g. SLR, 2021).

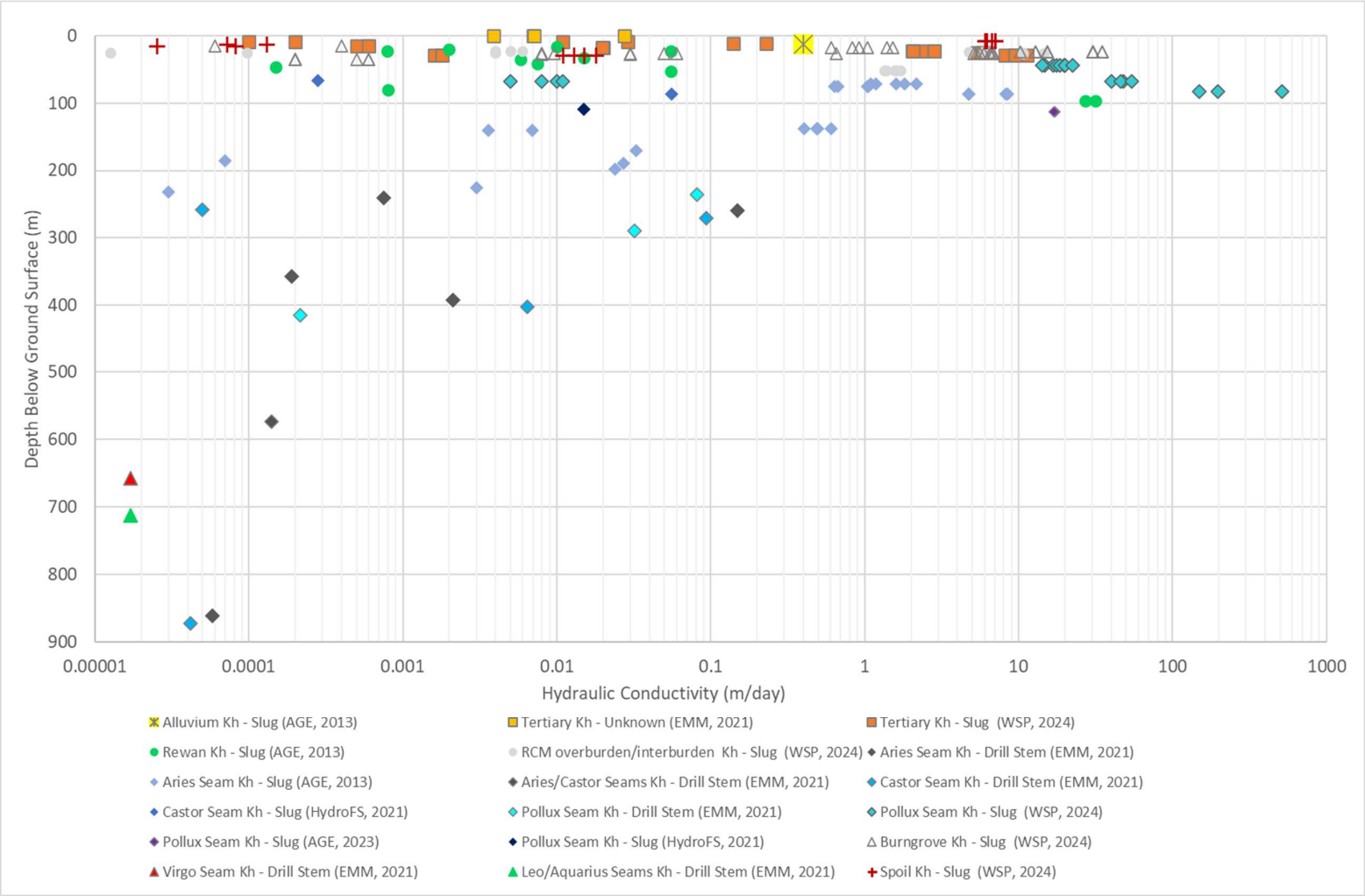
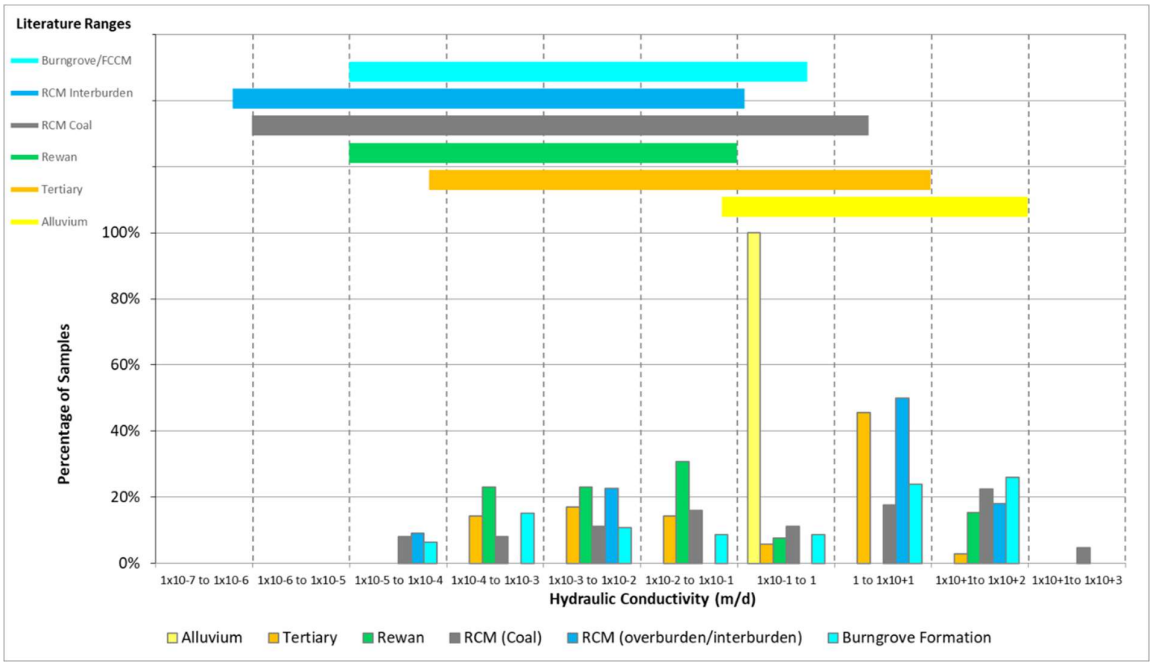


Figure 4-9 Graphical Summary of Results for all Site-Specific Hydraulic Conductivity Testing

4.2.2 Hydraulic Conductivity Ranges

A histogram of the spread of estimated horizontal hydraulic conductivity from field testing at BWM is presented in **Figure 4-10**. The results are compared to the range of horizontal hydraulic conductivity obtained from publicly available data based on a number of other studies within the Bowen Basin (SLR, 2023c).



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

Figure 4-10 Histogram of Horizontal Hydraulic Conductivity Distribution

The comparison shows that the majority of field results for alluvium, Tertiary strata, Rewan Group, RCM and Burngrove Formation within the Study Area generally fall within the range of field data collected through other studies across the Bowen Basin. The exception to this as mentioned above includes the estimates produced by WSP (2024) for the RCM and Burngrove around the Red Dam area and are possibly influenced by the presence of underground mining or voids and therefore may not accurately reflect the primary hydraulic conductivity of the formation (WSP, 2024). Additionally, results recorded from one bore in the Rewan Group (i.e. MB19BWM_16R) are higher than expected when compared to the documented ranges from literature, reflecting the fact that some parts of the Rewan Group has higher hydraulic conductivity. Results recorded for the RCM coal seams from one bores (BWM_MB16_03) was also higher than expected when compared to literature values. It is expected that in general across the Study Area the coal seams of the RCM and Burngrove Formation have a higher hydraulic conductivity than the majority of the interburden/overburden, consistent with many other regional studies (e.g. SLR, 2021). 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.

4.2.3 Faulting

As discussed in **Section 3.1.1**, the strata in the vicinity of the Project Area is heavily influenced by a series of easterly dipping, north to northwest striking faults.

As identified by Jourde et al. (2002), faulting can result in higher permeabilities within strata parallel with the fault plane, and lower permeabilities within strata perpendicular to the fault plane. However, this can also be dependent on whether faults are currently active (Paul et al., 2009). Faulting has been inactive within the Bowen Basin for over 140 million years (Clark et al., 2011), indicating that the fault zones are less likely to act as conduits to flow; this relates to filling of the fractured pore spaces over time through hydrothermal alteration and mineralisation (Uysal et al., 2000). Drill core logs from the Bowen Basin generally show that where fractures and faults have been geologically logged, many fractures are "healed" with calcite and siderite. This indicates that although the system contains a fracture network, many of the existing fractures are cemented, which reduces the effective permeability of the fracture when compared to any open fracture network (SLR, 2021).

Site specific testing of the faults has not been undertaken to derive hydraulic properties of the fault zones or assess whether the faults act as conduits or barrier to groundwater flow. However, they are anticipated to act more as barriers than conduits because the faults compartmentalise the coal seam geology and Permian groundwater flow is dominated by water movement within these seams.

Based on a detailed literature review of the effect of faulting on groundwater flow, Coffey (2014) has developed a conceptual model for fault zone hydraulic characterisation in the Bowen Basin (**Figure 4-11**), largely based on Jourde et al. (2002) and Flodin et al., (2001). This conceptualisation provides a means of inferring hydraulic conductivities of the fault core and the fault damage zone from regional hydraulic conductivity, with the fault core typically one to three orders of magnitude lower conductivity than the regional host rock, and the damage zone approximately an order of magnitude higher.

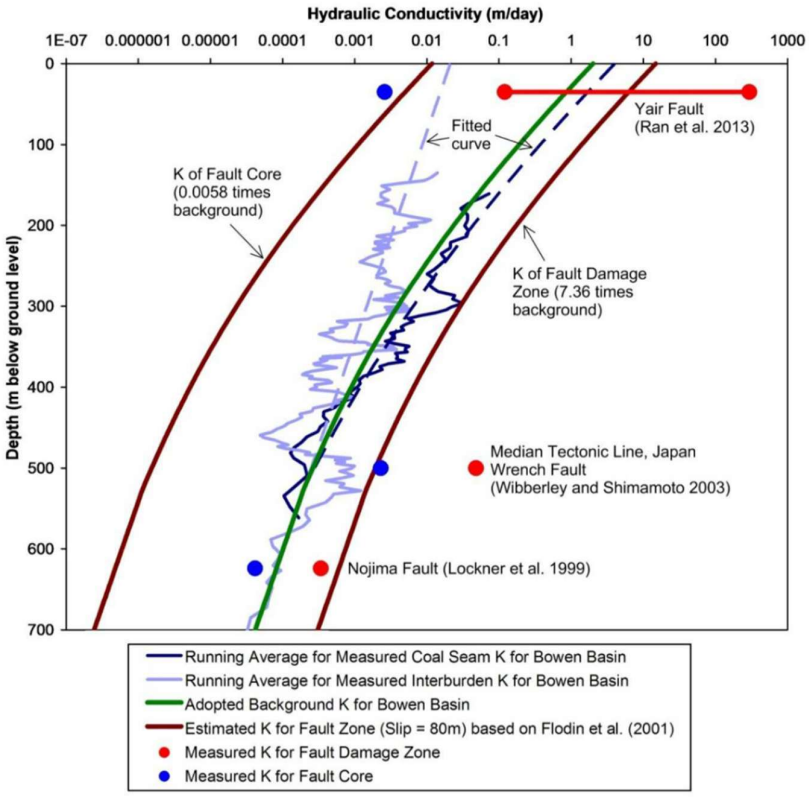


Figure 4-11 Faulting Conceptual Model Developed by Coffey (2014)

For this assessment, only one major fault, the Shotover Fault, was included in the groundwater model (refer to **Section 8.0**). The Shotover Fault is located approximately 15 km east of the EA boundary, near the eastern edge of the model boundary. It is an east dipping thrust fault with a displacement of up to 3,000 m (Mallet, 1988). As mentioned above, fault zones within the model boundary are likely to be "healed" with mineralisation, reducing effective permeability. This suggests that the Shotover Fault is more likely to act as a hydraulic barrier. In line with the IESC (2021) Explanatory Note: Characterisation and Modelling of Geological Fault Zones (Murray & Power, 2021), the Shotover Fault has been classified under Scenario A2: a fault acting as a barrier based on conceptual evidence, as no site-specific hydraulic testing has been undertaken. This classification reflects the current understanding that the fault core has significantly lower hydraulic conductivity than the surrounding host rock, and supports its representation as a no-flow boundary in the groundwater model.

This fault, the Shotover Fault, was included as a no flow boundary, based on the understanding that the fault core has a lower hydraulic conductivity than the host rock.

4.3 Groundwater Distribution, Flow, Rechange and Outflow

4.3.1 Quaternary Sediments (Alluvium)

Based on recent drilling at BWM (**Section 3.2.1**), it is considered that the horizontal extent of the Quaternary alluvium within the Study Area is likely smaller than mapped on the regional surface geology map (**Figure 3-1**).

Recent drilling campaigns targeting the alluvium in the north of BWM (2020 and 2021) revealed either an absence of alluvium, and/or dry conditions. In 2020, four bores were planned to be installed into the alluvium at north BWM, however only one of the four locations (bore MB19BWM07A at Taurus Creek) was able to be installed into the alluvium, which was then found to be unsaturated (AGE, 2020). Two bores were planned to be installed into the Two Mile Gully alluvium but did not intersect alluvium and were grouted up. A further two bores targeting the Sagittarius Creek alluvium were attempted to be installed, with one intersecting alluvium (MB19BWM02A) that was found to be unsaturated, and the other (MB19BWM05A) intersecting possible alluvium or possible Tertiary sediments that were also unsaturated. These two drillholes in Sagittarius Creek were converted to monitoring bores targeting the shallow weathered Rewan Group instead, where first shallow groundwater was found. Another bore (BWM_MB03_01) installed into the Taurus Creek alluvium, drilled in 2020 (EMM, 2021) has also been dry since installation.

In 2021, during an additional drilling campaign, bore MB20BWM01A initially targeted alluvium (near a small unnamed tributary of Bonnie Doon Creek) but again due to the lack of alluvial sediments at the site, the bore was installed into the water table in the shallow Rewan Group (HydroFS, 2021). In 2023, five additional bores were installed in the alluvium of Rockland Creek (four bores) and Shotover Creek (one bore) in the south of BWM, two of which (MB19BWM_14A and MB19BWM_19A) found the alluvium to be unsaturated.

Drilling results indicate that where the alluvium is present, it is generally dry, with saturated areas only found in few locations. There are six active BWM monitoring bores screened in the alluvium that have been considered for this assessment (**Figure 3-1**), however only one BWM_MB01_01 at Rockland Creek, just outside the eastern edge of the EA boundary, is saturated (**Figure 4-12** and **Figure 4-13**). It is noted however that there is no mapped alluvium in this area, rather the surface geology in the area is mapped as Tertiary sediments. Furthermore, the bore log shows the screened interval to be "clay sand, weathered" indicating that the bore may actually be screened in the Tertiary sediments or weathered Permian, rather than alluvium. The short data record available for this bore shows groundwater level elevation to range between approximately 15 to 16 mBTOC (255 to 256



mAHD) (**Figure 4-12** and **Figure 4-13**). The relatively deep recorded depth to groundwater of approximately 15 m below ground level where alluvial groundwater is encountered indicates a distinct lack of connection with any surface water features, and is also likely beyond the rooting depth of any terrestrial vegetation species.

Due to the general lack of saturated monitoring locations in the alluvium, and the limited period of data available, it is not possible to assess correlation with rainfall (and therefore recharge) based on these bores. However, based on a review of available groundwater level data for the neighbouring Minyango Project that was conducted by AGE (2013), recharge to the alluvium is suggested to be limited. Of the four bores installed into the alluvium at Minyango Project, three were also dry. The only bore that encountered water (Minyango-MB9) revealed a limited saturated thickness of less than 0.8 m, with a depth to water level of 10.8 mBGL. The monitoring data for MB9 showed a steady decline between December 2012 to September 2013, and showed no correlation with rainfall. AGE (2013) determined that, for bore MB9, recharge is likely limited by the surficial clay above alluvium and that the alluvium is likely compartmentalised, with limited connectivity between saturated alluvium areas, separated by clay lenses and outcropping bedrock. Where saturated, the alluvium may facilitate recharge to underlying geological units. Discharge from this aquifer is generally considered to be via evapotranspiration and leakage to underlying aquifers.

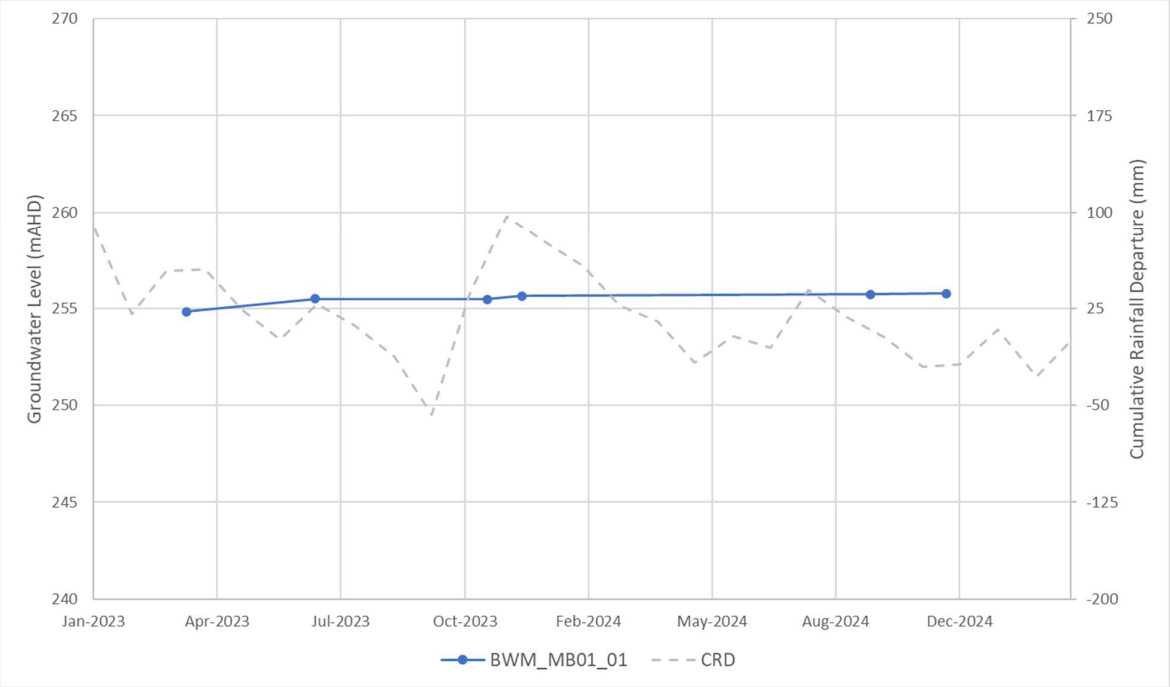


Figure 4-12 Groundwater Level (mAHD) – Alluvium

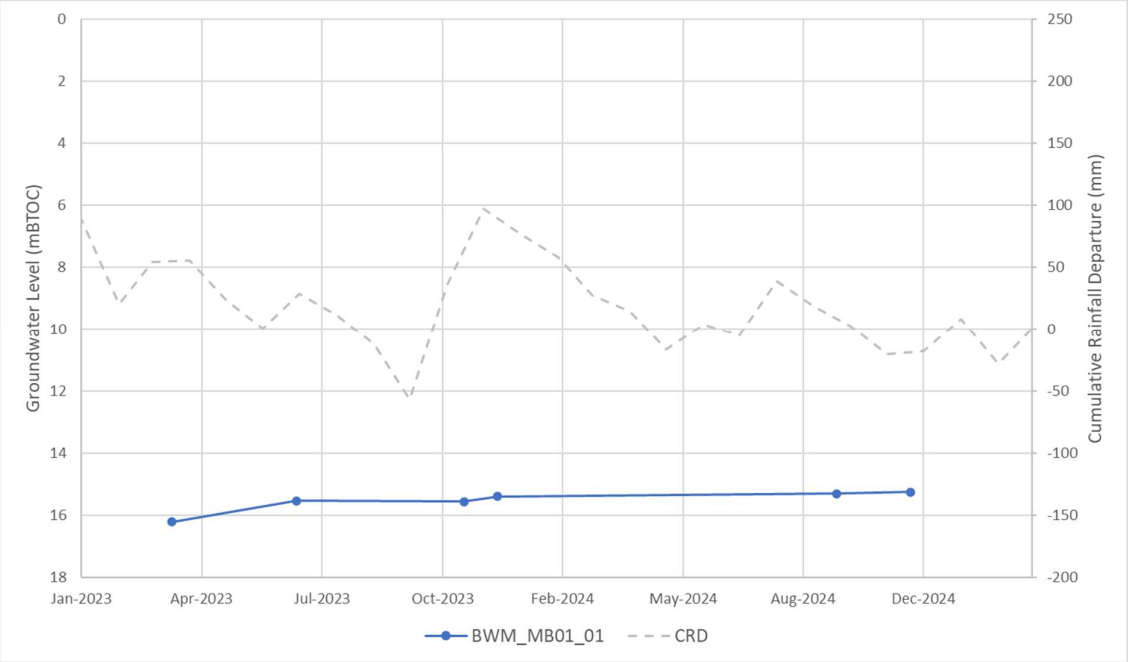


Figure 4-13 Groundwater Level (mBTOC) – Alluvium

Due to the general lack of saturated monitoring locations in the alluvium within the Study Area, it is not possible to map groundwater contours for this unit, nor is it likely that a widespread flow system in the alluvium exists. However, where saturation does exist, groundwater flow in the alluvium is expected to be controlled by topography and mimic surface water flow directions, with flow towards the north at North Blackwater and towards the southwest at South Blackwater.

4.3.2 Tertiary Sediments

The Tertiary unit forms the surficial (water table) aquifer, where the groundwater table exceeds the base of the unit (that is, in some locations at BWM the Tertiary unit is 'dry' and therefore does not form an aquifer). Groundwater levels for the three monitoring bores screening the Tertiary Sediments vary from approximately 240 mAHD (BWM_MB17_02) to 305 mAHD (BWM_MB15_01) (**Figure 4-14** and **Figure 4-15**). Bores BWM_MB12_01 and BWM_MB17_01 are also Tertiary EA bores but have been recorded as dry since installation so do not appear on the figures.

Groundwater levels in the Tertiary EA bores range from approximately 242 to 306 mAHD and 15 to 20 mBTOC. The longest monitoring record is available from MB21, which shows there has been a steady decrease in groundwater level since 2011, interrupted only by relatively short-term responses to large rainfall events. This long-term decline reflects a long-term response following the very high rainfall observed in 2011 and/or drawdown from mining. Groundwater levels in BWM_MB15_01 and BWM_MB17_02 over the relatively short monitoring period have remained stable, showing no response to rainfall trends or any mine-related influences. This is consistent with the conceptualisation of the Tertiary unit, where recharge from rainfall infiltration is expected to be low due to the presence of surficial clays. Notably, bore BWM_MB15_01 sits at the highest ground elevation of any of the Tertiary EA bores and hence has the highest groundwater level elevation of any of the Tertiary EA bores, noting that the natural water table elevation typically forms a subdued reflection of topography.

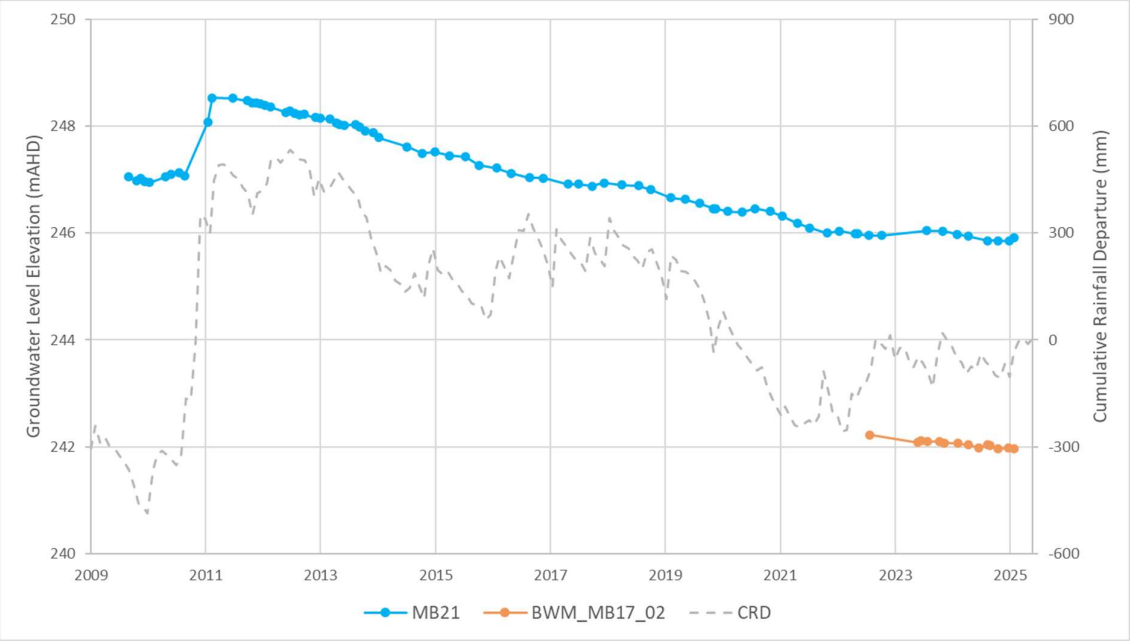


Figure 4-14 Groundwater Levels (mAHD) – Tertiary EA Bores (MB21 and BWM_MB17_02)

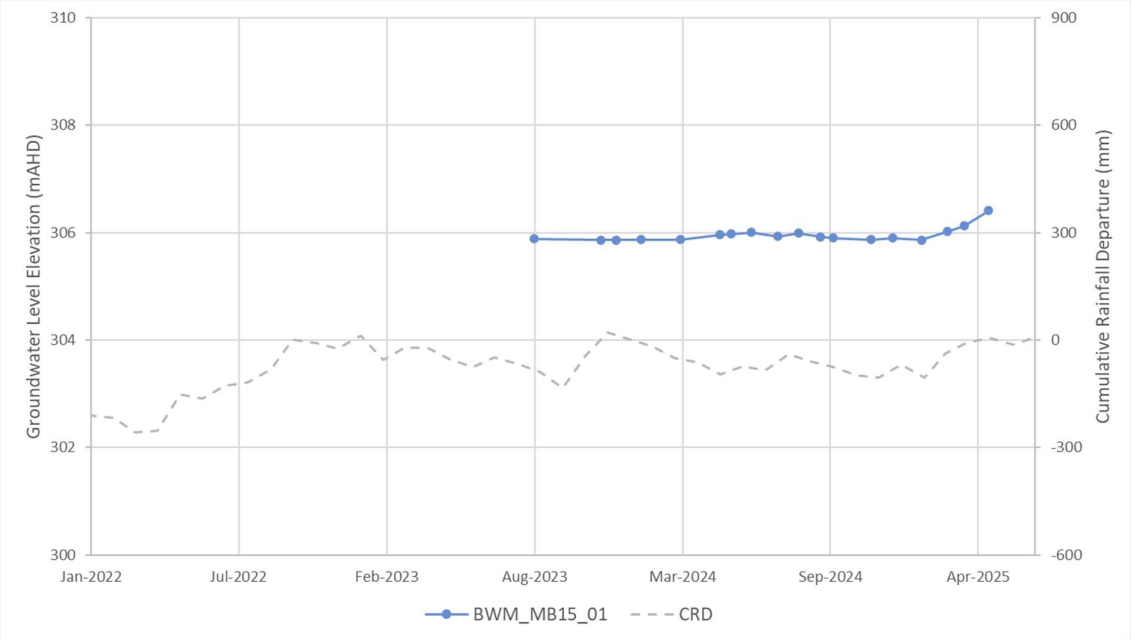


Figure 4-15 Groundwater Levels (mAHD) – Tertiary EA Bore (continued) (BWM_MB15_01)

Across the BWM site, groundwater flow in the Tertiary unit is expected to generally follow topography (where not influenced locally by mining activities), with natural outflow from the unit considered to be primarily through evapotranspiration and leakage to underlying aquifers. Similar to the alluvium, groundwater flow in the Tertiary units is expected to be controlled by topography and flow towards the north at North Blackwater and towards the southwest at South Blackwater.

4.3.3 Clematis Group

The aquifer forming Clematis Group sandstones are distinguished by coarse grain size, with less interbedded shale and siltstone than the non-aquifer forming Clematis Group units. There are no registered bores within the Clematis Group sandstone, as the sandstone outcrops in elevated rugged areas in Arthur's Bluff State Forest, Shotover State Forest and Blackdown Tableland National Park. Claystones of the Rewan Group directly underlie the Clematis Group, forming an aquitard between the Clematis Group and the deeper Permian Coal Measures.

4.3.4 Rewan Group

Regionally across the Bowen Basin, the Rewan Group is considered an aquitard (DNRM, 2016), given its low yielding nature, with any groundwater having limited potential for beneficial use due to the typically fine-grained, clay-bound nature of the sediments. Although, it is noted, that local permeability may be sporadically higher in the upper weathered zone of the unit permitting minor groundwater storage and transmission.

Groundwater level data for the two BWM EA bores installed into the Rewan Group is provided as (**Figure 4-16**). The monitoring data shows groundwater levels in these bores range between approximately 161 to 170 mAHD.

Both bores show stable groundwater levels with little variation in groundwater level over the monitoring record, approximately 1 m for MB19BWM02A and 0.1 m for BWM_MB03_02. The small 1 m increase occurring in MB19BWM02A between mid-2020 and early 2023 appears to be a subdued response to a relatively sustained period of above average rainfall. MB19BWM02A and BWM_MB03_02 generally show stable water levels over the monitoring record with no response to short term rainfall CRD peaks, indicating a degree of insulation from short term recharge events.

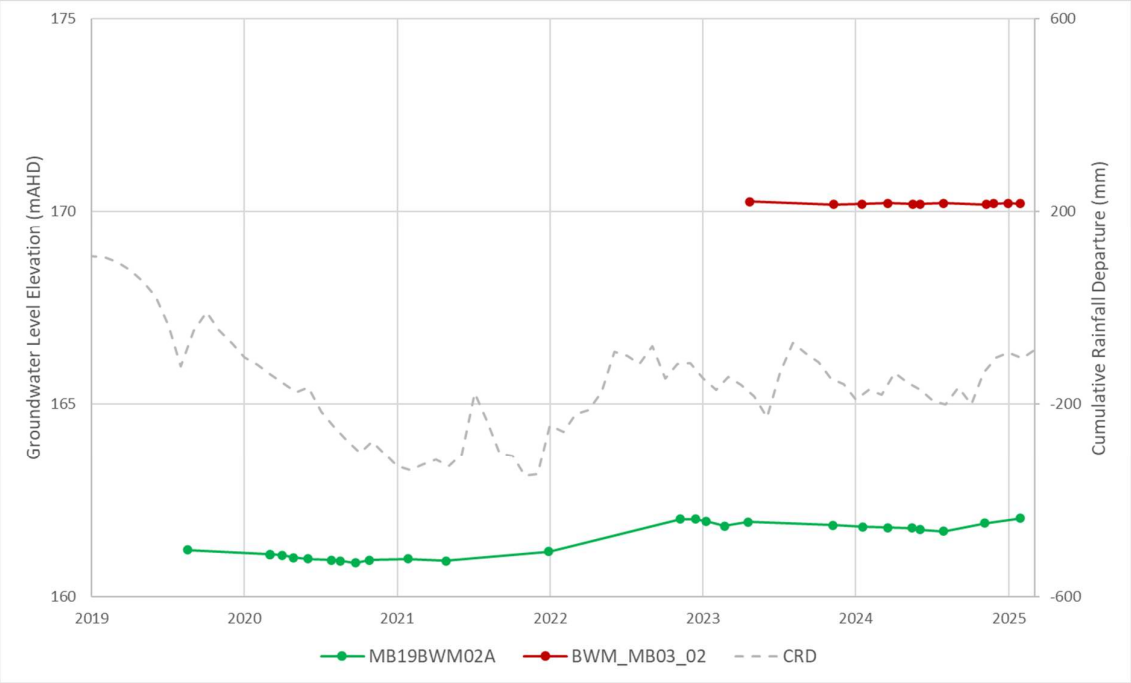
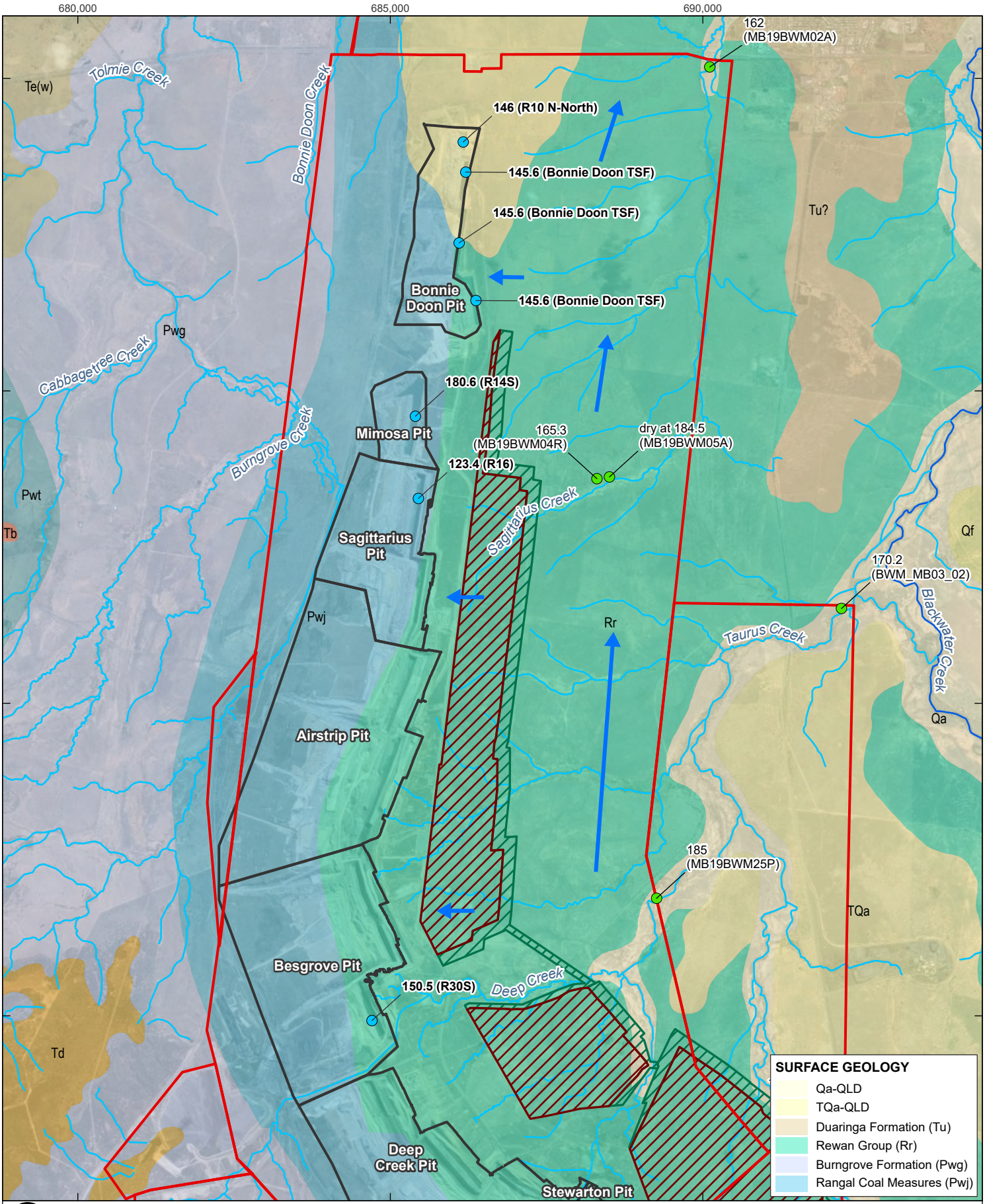


Figure 4-16 Groundwater Levels (mAHD) – Rewan Group

Recharge to the Rewan Group is expected to occur via leakage from the overlying Quaternary and Tertiary units. Recharge rates are likely very low due to the low hydraulic conductivity of the interbedded fine grained clay horizons restricting infiltration. This is supported by elevated salinity (see **Section 5.1.2**) which is consistent with high groundwater residence times concentrating salts.

Outflow from this unit is expected to be through lateral flow, with low vertical hydraulic conductivity limiting potential leakage to underlying units. The suggested insulation of this unit from recharge events makes it unlikely that there would be short term (post-rainfall) groundwater pressure increases sufficient as to discharge to surface water features.

Available groundwater levels from the monitoring bores grouped in the northern area indicate a flow toward the north of BWM (i.e. consistent with topographical gradients) and potentially (if the Rewan Group is saturated in this area) also locally towards the pits that report lake levels significantly below the groundwater levels in the nearest bores screened in the Rewan Group (**Figure 4-17**). As shown on **Figure 4-4** there is only one bore screened in the Rewan Group in BWM south however, groundwater flow in the southern portion of BWM is also expected to follow topography, with a flow direction towards the south and southwest.



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
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Drawn by:	AS

LEGEND

- Water Level - mAHD (Pit)
- Bore (Groundwater Level – mAHD)
- Groundwater Flow Direction
- Major Watercourse
- Minor Watercourse
- BWM Mining Lease
- Historical Pit Extent
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER FLOW DIRECTION IN THE REWAN GROUP (BWM NORTH)

SLR

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FIGURE 4-17

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_F05_16 Groundwater Flow Direction in the Rewan Group (BWM North)

4.3.5 Rangal Coal Measures

The following conceptualisation of groundwater distribution, flow, recharge and outflow for the RCM is discussed separately for the North (**Section 4.3.5.1**) and South (**Section 4.3.5.2**) areas of BWM as shown on **Figure 2-5**. This division is a reflection of the very large north-south strike length of BWM and fact that, broadly, the Permian groundwater system appears divided across BWM on the basis of the broad scale topographically driven surface water catchments, being the upper Mackenzie River sub-catchment for North and Central BWM and the Comet River sub-catchment for South BWM.

4.3.5.1 BWM North Area

Groundwater level data for the RCM EA bores in the BWM North area (**Figure 2-5**) is shown on **Figure 4-18**. Groundwater levels from these bores range from approximately 143 to 245 mAHD.

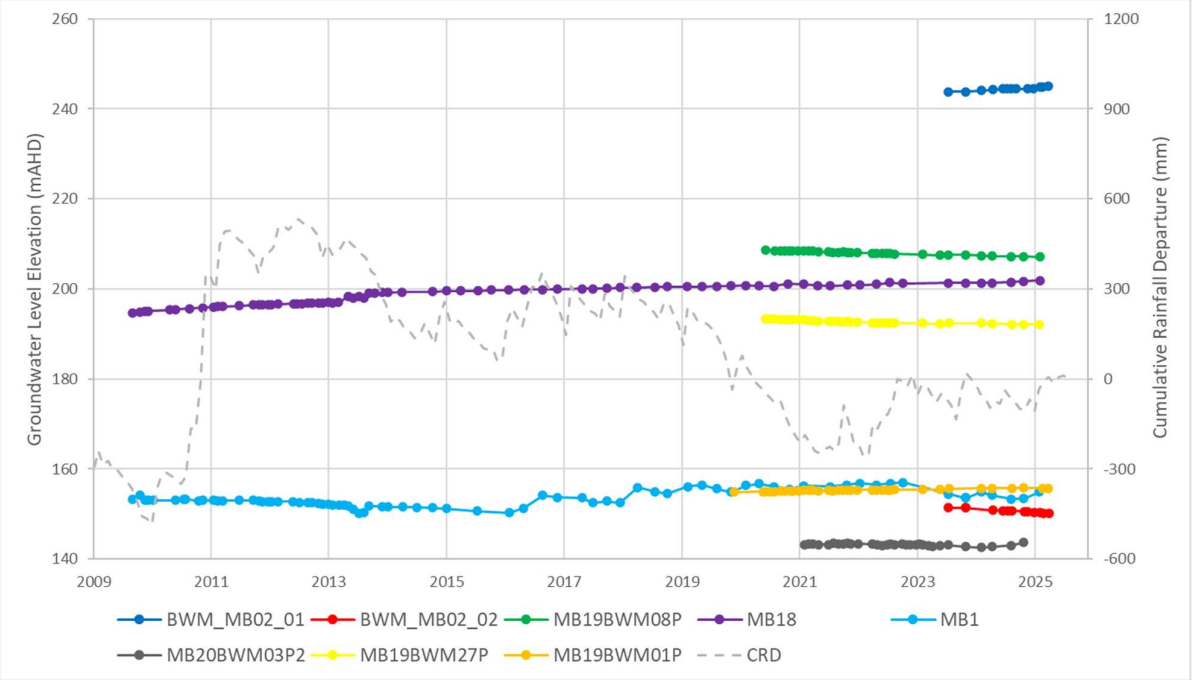


Figure 4-18 Groundwater Levels (mAHD) – Rangal Coal Measures EA Bores (BWM North Area)

A comparison of the groundwater level trends shown against the Cumulative Rainfall Departure (CRD) indicates that the groundwater regime in the RCM is somewhat insulated from short term climatic effects. As shown on **Figure 4-18**, groundwater elevation at MB1 (monitoring the Aries seam), which has the longest monitoring record, gradually but marginally increased between the cessation of Bonnie Doon Pit mining in 2016 and the beginning of 2023, before declining slightly in 2024 but remaining relatively steady thereafter. Given this bore has a groundwater elevation well above the nearby pit water levels, this is considered to be a hydraulic response of the RCM recovering following the removal of dewatering stressors, rather than an indication of recharge from pit lakes. The monitoring record at MB20BWM03P2 (monitoring the Castor/Pollux seams) which also monitors the area of the RCM immediately east of the Bonnie Doon Pit / in-pit Tailings Storage Facility (TSF) area shows relatively stable groundwater levels over its monitoring record. MB19BWM01P and MB19BWM27P also monitor the Aries seam and show little

variation in water level over the monitoring record, with MB19BWM01P steadily increasing approximately 0.8 m and MB19BWM27P steadily declining approximately 1.2 m. Groundwater elevation at MB19BWM27P is notably higher than the other EA bores monitoring the Aries seam (i.e. MB1 and MB19BWM01P), reflective of an overall south to north inferred groundwater flow direction. Groundwater elevation is also lowest at MB20BWM03P2 monitoring the Castor/Pollux seams below the Aries seam, indicating a downwards hydraulic gradient (and flow potential) from the Aries seam to the Castor/Pollux seams.

Relatively low groundwater levels at BWM_MB02_02 are taken to indicate a drawdown influence from mining activities attributable to its location between BWM's Blackdown and Wilpeena Pits to the west of the bore, and the Cook Colliery underground mine to the east outside of the BWM mining lease and EA boundary. Bore MB18, which is screened in the RCM overburden, has the longest monitoring record and shows an overall increasing trend in groundwater level from 2010 to current. MB19BWM08P shows a groundwater level of around 207 mAHD, whereas the groundwater level at adjacent shallower MB18 is around 202 mAHD, indicating an upwards hydraulic gradient from the confined coal seams into the aquitard overburden material. BWM_MB02_02 (Castor Seam) and BWM_MB02_01 (screened in the shallow overburden) show approximately 90 m of head separation, indicating a downwards hydraulic gradient and flow potential.

4.3.5.2 BWM South Area

Groundwater level data for the RCM EA bores in the BWM South area (**Figure 2-5** is shown on **Figure 4-19**. Groundwater levels from these bores range from approximately 234 to 275 mAHD, and display a relatively stable monitoring record. Likewise with the RCM bores across BWM North, the comparison of the groundwater level trends shown against the CRD indicate that the groundwater regime in the RCM is somewhat insulated from short term climatic effects. BWM_MB12_02 monitors the castor seam and shows little variation in water level over the monitoring record, with approximately 1.9 m increase between 2022 and 2023, and only around 0.1 m variation since. BWM_14_01 and BWM_14_02 both monitor the overburden and also show little variation in water level, with both bores steadily increasing approximately 0.3 m over the monitoring record. Notably, BWM_14_01 (shallow overburden) and BWM_14_02 (deep overburden) show approximately 12 m of head separation, indicating a downwards hydraulic gradient.

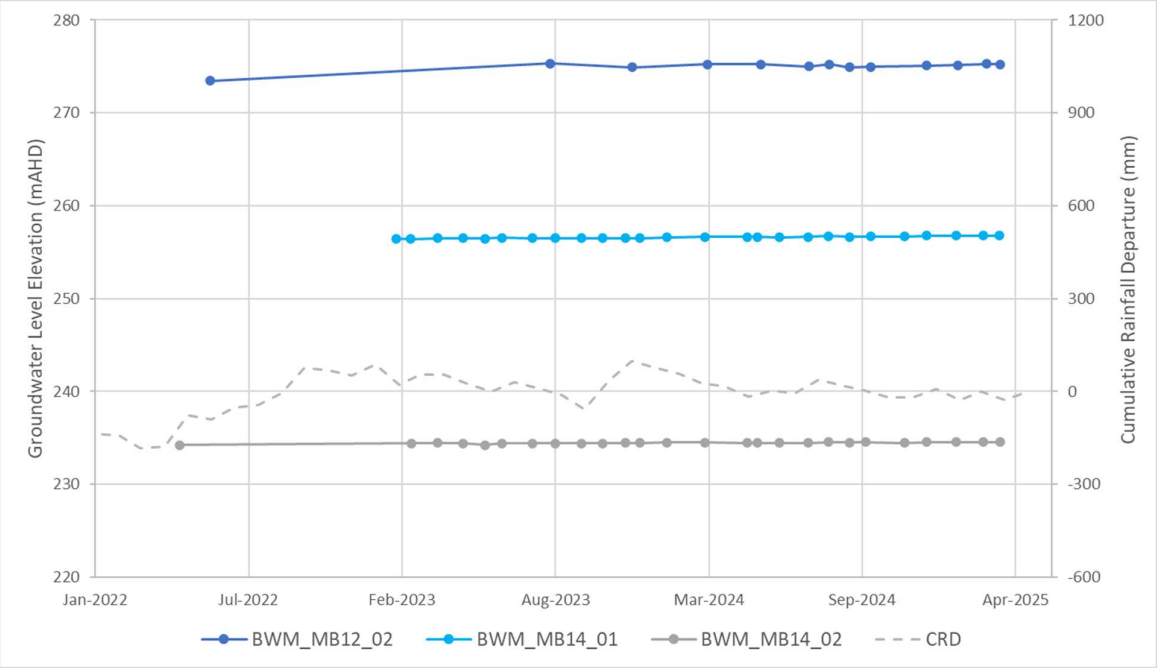


Figure 4-19 Groundwater Levels (mAHD) – Rangal Coal Measures (Southern Area)

Available groundwater levels for the now decommissioned bore MB16 are shown in **Figure 4-20**. MB16 is suggested by EMM (2021) to monitor the Aries Seam (or Aries Seam workings) within the extent the historic Laleham Underground Mine, which extracted coal from the Aries to the Pollux Seams (Byrnes Geotechnical, 2024). Groundwater levels at MB16 were approximately 223 mAHD (58 mBGL) prior to 2015, after which a gradual increase in water level occurred to approximately 243 (39 mBGL) mAHD to 2018 before stabilising. This water level increase of approximately 19 m is likely to be related to partial recovery of water in the underground workings (EMM, 2021), i.e. reflooding. Groundwater levels at MB16 are noted to remain significantly lower in elevation than water storage elevations within the Kenmare pit (287.4 to 276.6 mAHD, see **Section 2.3.3**), suggesting there remains the potential for groundwater movement towards the underground workings from water stored in this pit. The groundwater levels at MB16 are also marginally lower in elevation than the most recent pit lake level recorded within the Ramp 74/Laleham pit (246.4 mAHD), though the difference is relatively small and suggests that the underground workings may have essentially reached close to hydraulic equilibrium with the Ramp 74/Laleham pit.

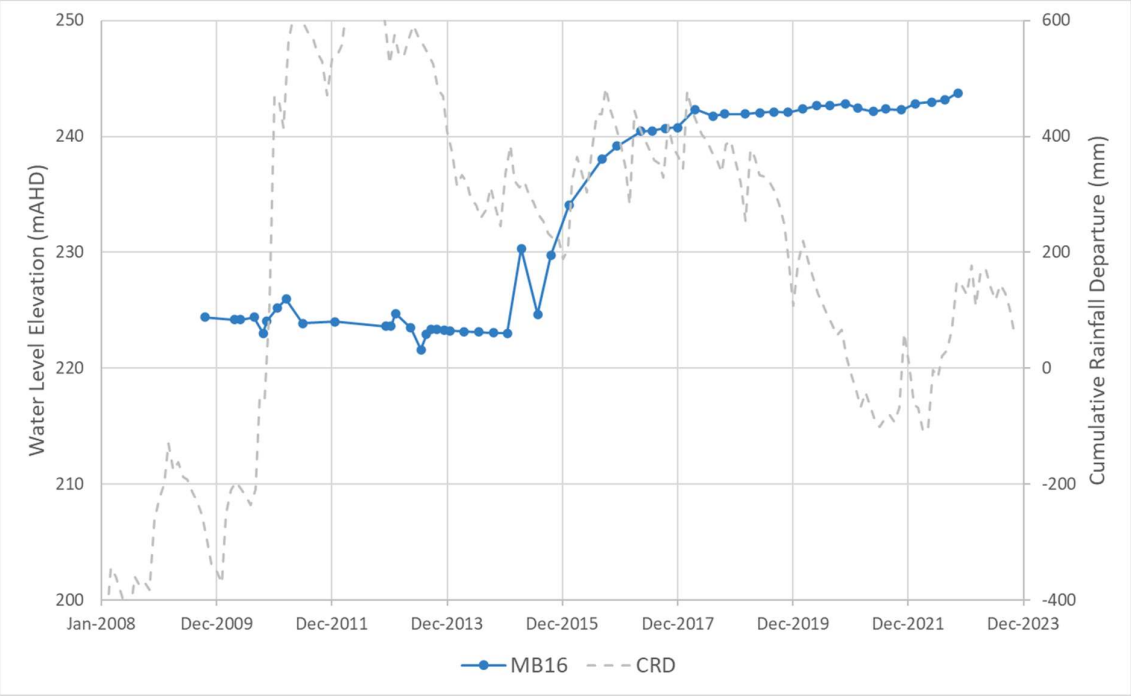


Figure 4-20 MB16 Groundwater Level (mAHD) – (Laleham Underground Mine)

4.3.5.3 Summary

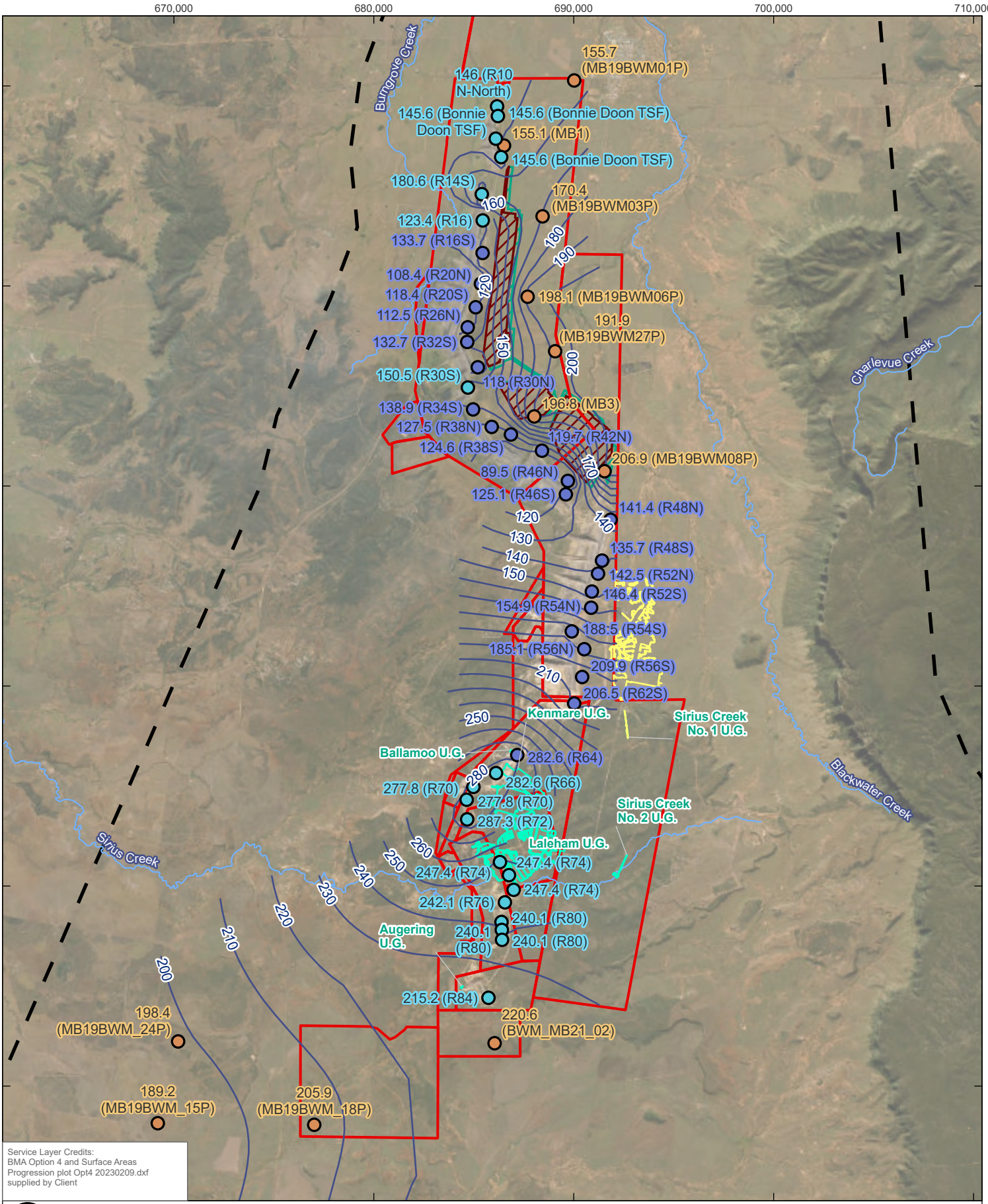
A comparison of groundwater level trends for all BWM bores screened in the RCM coal seams against the CRD indicates that the groundwater regime in the RCM coal seams is somewhat insulated from short term climatic effects, though depth and conductivity of the monitored horizon clearly influences this response. Through hydraulic connection with the mining areas, it is apparent that there is some response in regional groundwater levels to mining depressurisation.

Groundwater quality in the RCM coal seams is mostly saline (**Section 5.1.2**), which suggests long residence times related to low recharge rates and increased water-rock interaction. Recharge to the coal seams is expected to occur primarily via leakage from the overlying Quaternary and Tertiary units, with greater recharge occurring in areas where the seams subcrop and outcrop. Based on the inferred hydraulic gradients between overburden and coal seams, this is likely limited to the overburden horizons, with coal seam recharge occurring through mine surface water storages where the seams are hydraulically connected to the storages. Outflow from the RCM is considered to be primarily through inflow to active mining areas, within the cone of depression. Where groundwater is not influenced by the cone of depression, outflow will occur downdip following regional flow path to the east.

Groundwater level contours for the Aries Seam are shown as **Figure 4-21**. The Aries Seam was selected as it has the highest number of data points and most recent data available for analysis, and it is expected that other coal seams would exhibit similar flow patterns. The contours are based on the most recently available groundwater level measurements from bores screened in the Aries Seam. The most recent available pit water levels are also included in the mapping to assist with the interpretation of RCM groundwater flow direction as it provides an indication of the groundwater level in the RCM directly adjacent to the pit, since there is direct hydraulic connection between the pits and the RCM. Where there are no in-pit water storages, the base elevation of the pits (based on most recently available LiDAR in February 2024) are also shown as groundwater levels must be below the base of the pits

in the case of dry pits, with any groundwater inflow passively managed through evaporation and the use of in pit sumps.

As shown on **Figure 4-21**, the groundwater flow direction in the BWM north area is locally predominantly towards the mine pits, consistent with discharge to the active mine pits. In the southern area of BWM, the flow direction within the Aries Seam is dominated by the local influence of elevated in-pit water storages at Kenmare Pit. In the far south, the potentiometric mapping indicates a groundwater divide present just north of Sirius Creek, consistent with the surface catchment divide (refer **Section 2.2**), with groundwater flow from northeast to southwest. As mentioned above, it is expected that the lower coal seams would exhibit similar flow patterns, however this does not apply to the Castor, Pollux and Orion seams in the area of the Cook Colliery. In this area the groundwater flow direction in these seams would be dominated by the local influence of dewatering, with the local groundwater flow direction therefore predominantly towards Cook Colliery.



Coordinate System:	GDA2020 MGA Zone 55
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Drawn by:	RB

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER LEVEL CONTOURS – ARIES SEAM

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FIGURE 4-21

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_F05_20_GWL Levels Aries Seam

4.3.6 Burngrove Formation

There are two monitoring bores installed in the Burngrove Formation, both are located to the northwest of the Project. **Figure 4-22** show the groundwater levels in these bores, 'BG No.1 AP' and 'BG No.2 BG'.

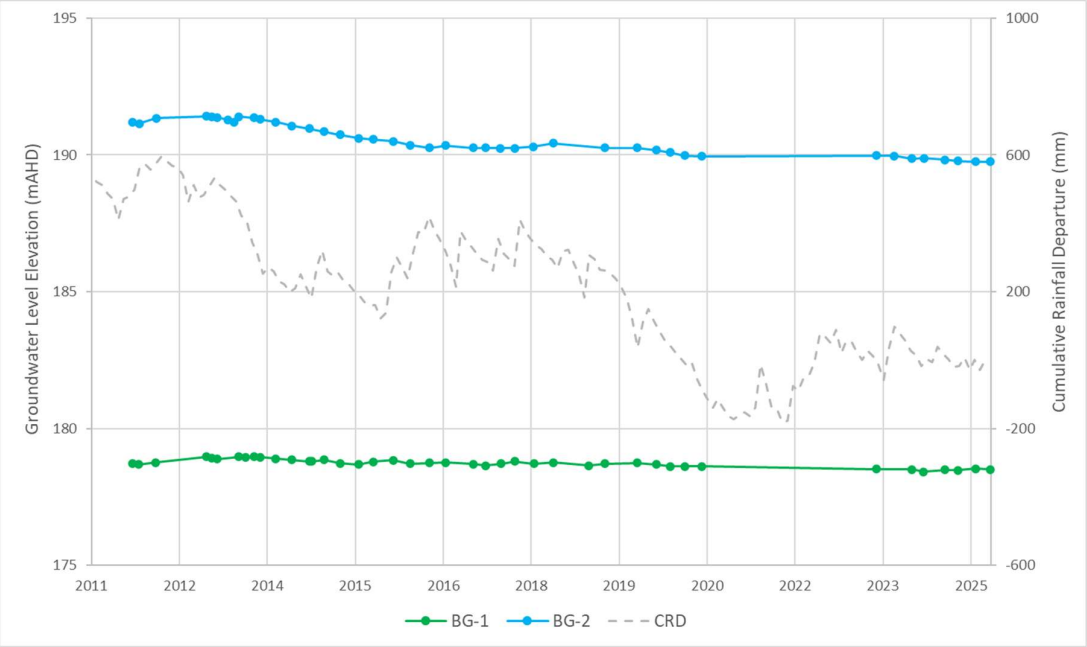
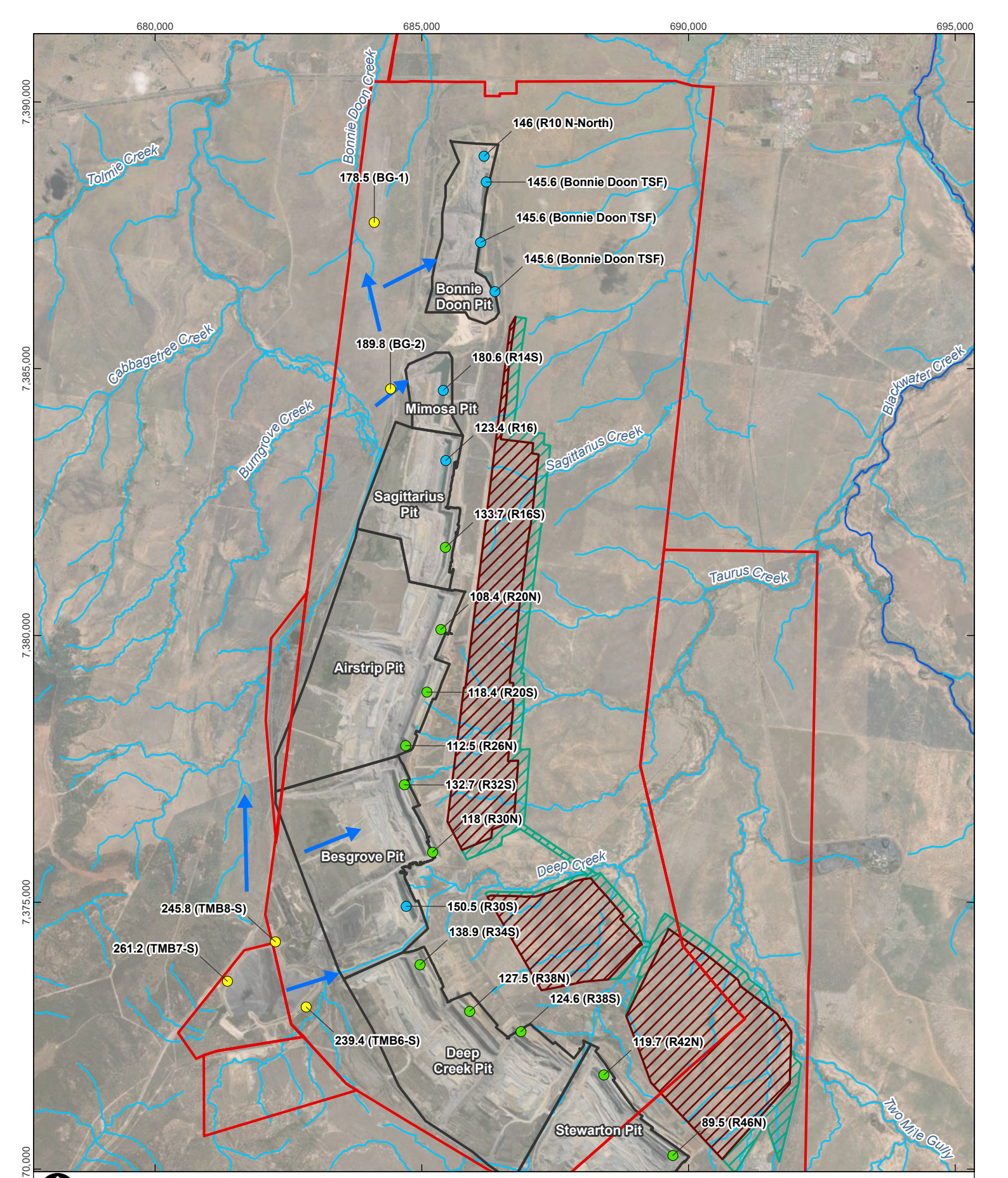


Figure 4-22 Groundwater Levels (mAHD) – Burngrove Formation EA Bores

The monitoring data shows groundwater levels in these bores range between approximately 178 to 191 mAHD. Both bores show little variation in groundwater level over the monitoring record, approximately 0.5 m for BG-1, and 1 m for BG-2. These variations are consistent with the overall long-term decline of the CRD over the corresponding monitoring record. Groundwater levels in these bores do not seem to respond to short term increases in the CRD, suggesting low rates of rainfall-derived recharge in these areas. Recharge to the Burngrove Formation would occur primarily where the formation outcrops along the west of the Project Area (**Figure 3-1**). Outflow from this formation is expected to be through lateral flow in the direction of regional groundwater flow, with some upwards leakage to the depressurised RCM.

The groundwater flow direction at BWM north is inferred to be overall towards the north-northwest consistent with topographical gradients and surface water flow patterns. The local flow direction near the pits is towards the northeast, consistent with the concept of local groundwater discharge to the pits. It is noted that the magnitude of the local hydraulic gradient towards the pits (east-northeast) is much greater than the north-northwest flow component as inferred by the larger head difference between data points over a shorter distance. This indicates that that magnitude of groundwater flow towards the pits is significantly greater than groundwater flow to the north-northwest. In the area of the NCPP, the local flow direction is towards the east, consistent with the drainage line that runs towards Deep Creek. As shown on **Figure 4-1** and **Figure 4-6** the only other bores screened in the Burngrove Formation in BWM south are grouped closely around the Red Dam area and hence are not useful in inferring regional flow direction, however, groundwater flow in the southern portion of BWM is expected to follow topography, with a flow direction towards the south and southwest.



Coordinate System:	GDA2020 MGA Zone 55
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Project Number:	640.031809.00001
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Drawn by:	RB

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER FLOW DIRECTION IN THE BURNGROVE FORMATION (BWM NORTH)

SLR

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FIGURE 4-23

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_F05_22_GW Flow Direction in the Burngrove Formation (BWM North)

5.0 Baseline Water Quality

5.1.1 Groundwater Typing

The proportions of major anions and cations were used to determine the hydrochemical facies of groundwaters sampled at BWM. The anion-cation balance, pH and EC of historical data from BWM monitoring bores is displayed on the Durov diagrams in **Figure 5-1** to **Figure 5-6**. The diagrams are split by aquifer and area, including bores in the alluvium (**Figure 5-1**), Tertiary (**Figure 5-2**), Rewan Group (**Figure 5-3**) and RCM at BWM north (**Figure 5-4**), RCM at BWM south (**Figure 5-5**) and the Burngrove Formation (**Figure 5-6**). There is a high degree of observed variability in groundwater quality between hydrostratigraphic units, and between individual bores within individual hydrostratigraphic units.

Records from alluvium groundwater quality sampling only include one bore across three samples (**Figure 5-1**). The data from this bore shows a Na-Cl groundwater type with a neutral pH and variable EC results ranging from 6,900 to 23,800 µS/cm.

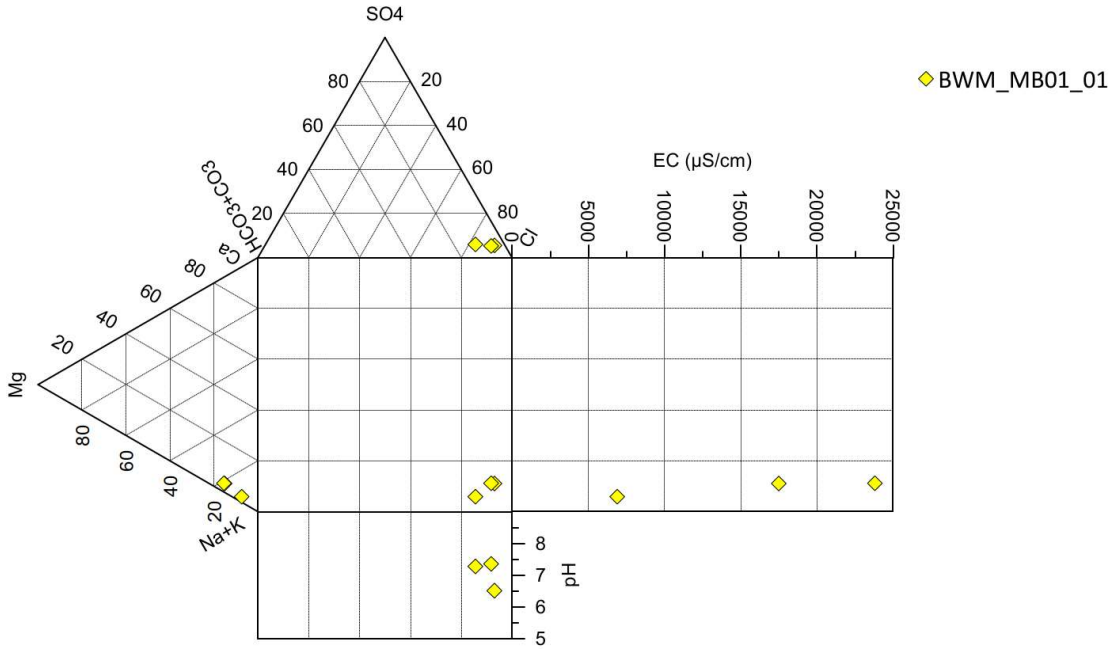


Figure 5-1 Durov Diagram – Alluvium

A Durov diagram for the monitoring bores screened within the Tertiary strata is presented as **Figure 5-2**. The bores are screened within the sediments/weathered strata of the Tertiary and located at BWM south. Bores MB21 and BWM_MB15_01 records a Na-Cl type groundwater, while BWM_17_02 records a Na-CO3-HCO3 water type.

The influence of HCO3 on the water chemistry of BWM_17_02 records, along with the comparatively fresh EC (500 µS/cm) is suggestive of direct rainfall recharge at this location. This direct recharge may be an influence of infiltration from Rockland Creek, located 150 m north of the bore

Historical groundwater data from the Tertiary strata bores shows an EC range of from 500 to 16,800 µS/cm with a median of 13,500 µS/cm. pH data ranges from 3.3 to 8.4 with a median of 7.4. Bore BWM_MB15_01 has a notably low pH of 3.3 and relatively saline EC value (6160 µS/cm).

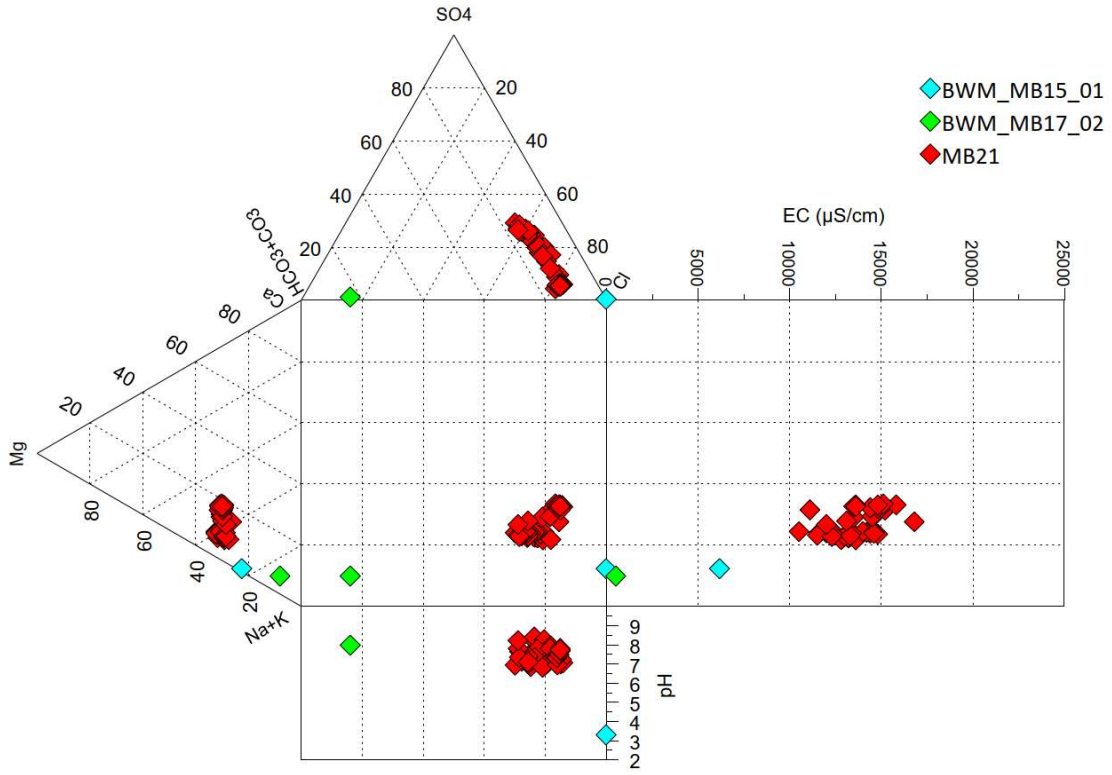


Figure 5-2 Durov Diagram – Tertiary Strata

Bores BWM_MB03_02 and MB19BWM02A are screened in the and record Na-Cl type groundwaters (**Figure 5-3**). Both bores record relatively high EC values ranging approximately 30,500 to 40,000 µS/cm. Recorded pH from bores in the Rewan Group ranges from mildly acidic to mildly alkaline (pH range 6.8 to 7.8), with a median pH of 7.2.

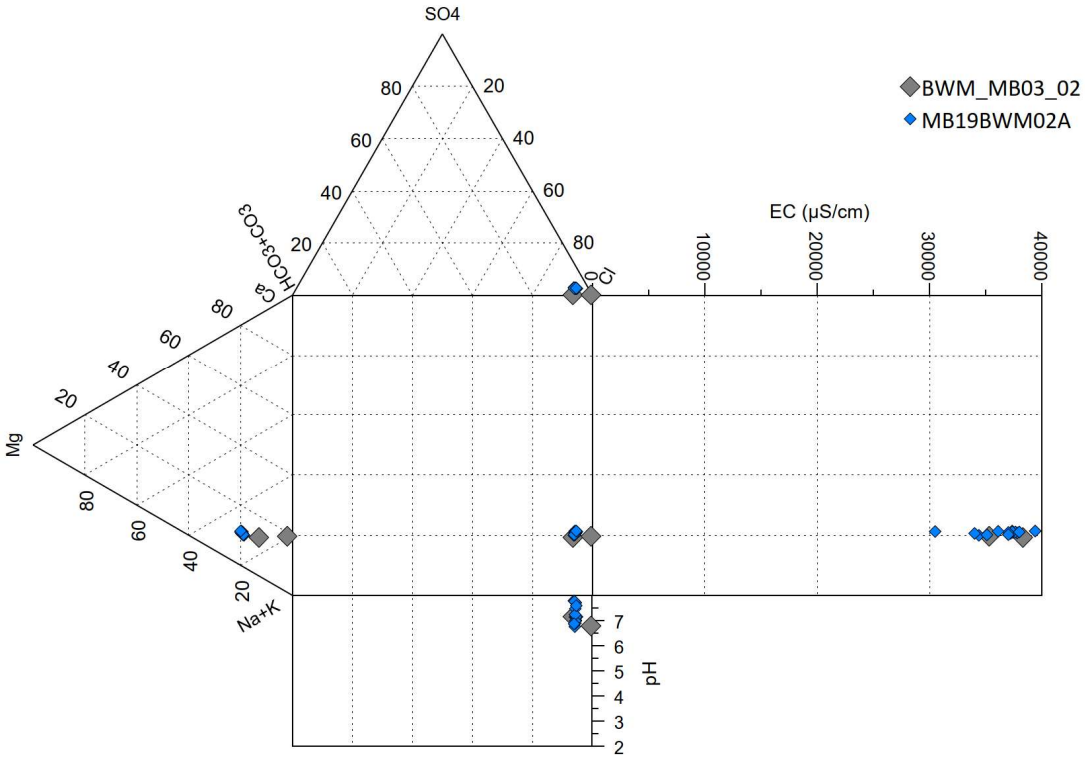


Figure 5-3 Durov Diagram – Rewan Group

The chemical analysis of groundwater from 11 bores targeting the RCM is shown on **Figure 5-4** to **Figure 5-5**. Results from these bores indicate that groundwater within this unit is generally Na-Cl water type. Exceptions to this the five bores , namely BWM_MB02_01, BWM_MB12_02, MB19BWM08P, MB19BWM27P, and BWM_MB14_02. These bores show distinctly different groundwater types, plotting as Na-Cl-HCO3 types.

Groundwater in the RCM generally has a median EC of 17,300 µS/cm, but ranges from 1,870 to 36,900 µS/cm. Recorded pH is generally neutral (median value of 7.7), however the data ranges from values between 6.9 to 11.9. Outliers occur, with high pH (of between 9 and 12) at bores MB19BWM01P, MB19BWM01P,. The elevated pH at these bores is likely unrepresentative of natural conditions and may be due to water interaction with residual cement grout from the bore construction.

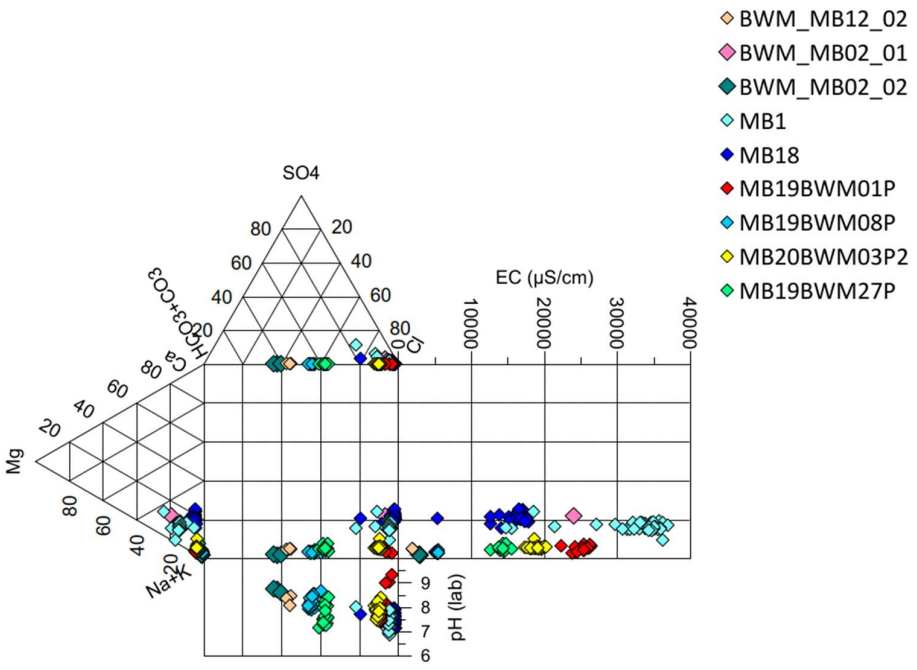


Figure 5-4 Durov Diagram – RCM (North BWM)

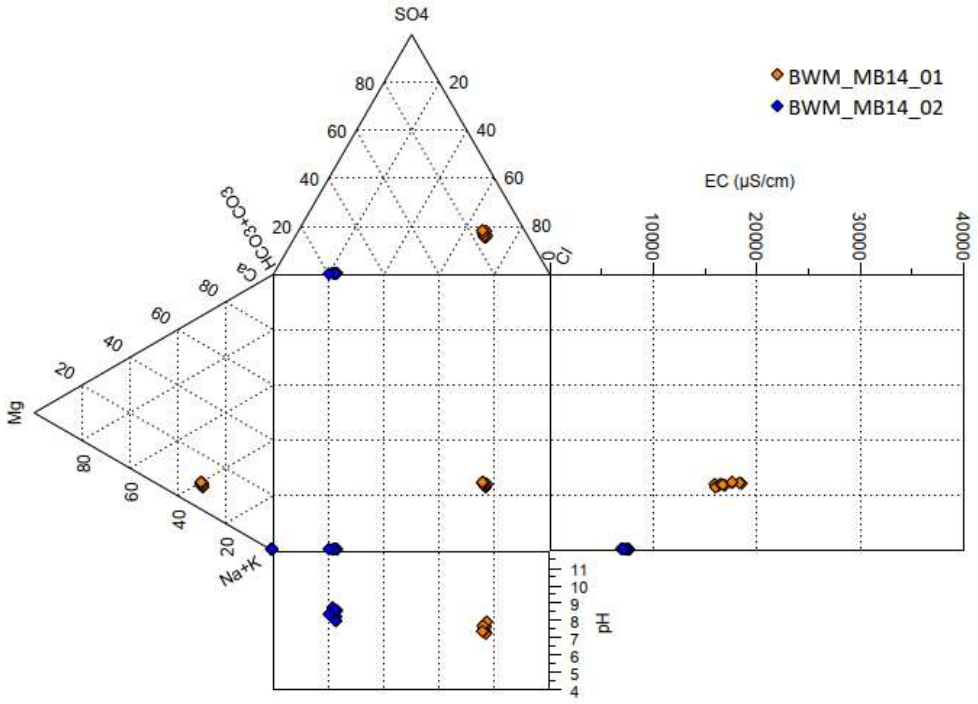


Figure 5-5 Durov Diagram – RCM (South BWM)

Groundwater from two bores screened in the Burngrove Formation record Na-Cl groundwater type (**Figure 5-6**). The results are tightly clustered which suggests that groundwater in the Burngrove Formation has a distinct water chemistry. Groundwater has a median EC of 12,500 µS/cm and ranges from 6,190 to 21,500 µS/cm. pH data shows a range from 7.10 to 8.9, with a median value of 8 indicating the groundwater pH is generally around neutral to slightly alkaline.

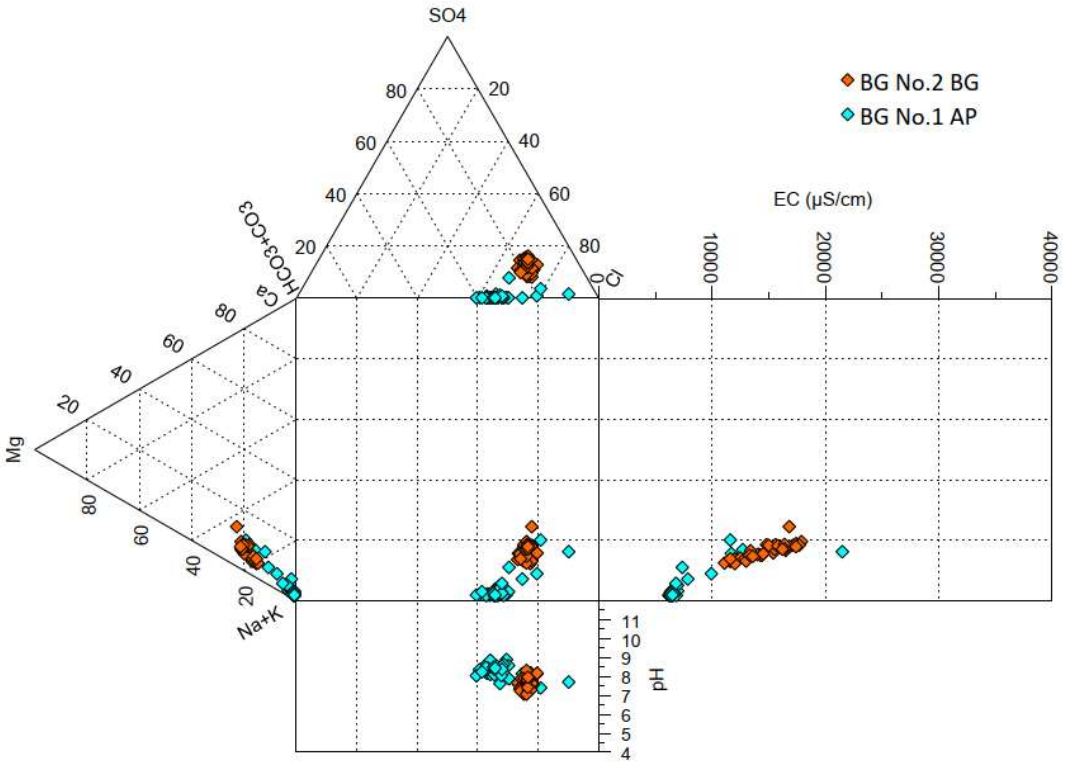


Figure 5-6 Durov Diagram – Burngrove Formation

5.1.2 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 5-7** presents the TDS data associated with waters screened in the various hydrostratigraphic units for BWM monitoring bores. Salinity ranges represented on **Figure 5-7** are defined by the Food and Agriculture Organization of the United Nations (FAO, 2013).

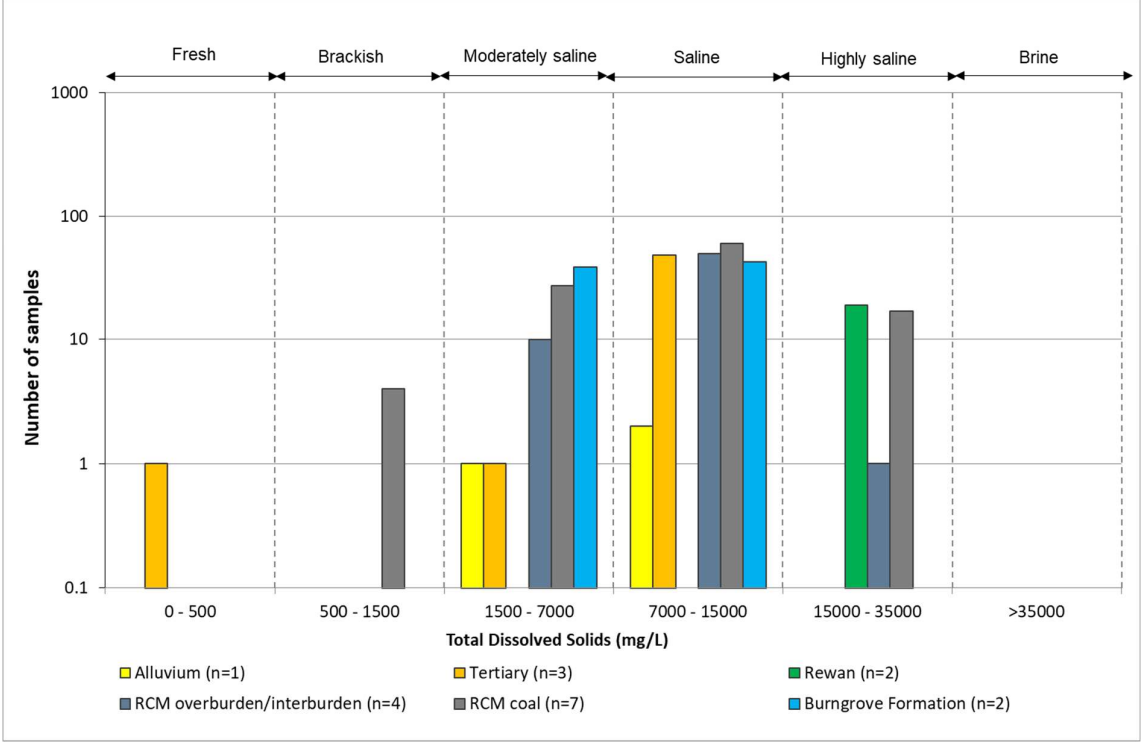
The graph shows that available data from one bore in the alluvium records TDS ranging from moderately saline to saline, with an average TDS of 8,983 mg/L and range between 4,250 mg/L and 11,600 mg/L.

Groundwater in the Tertiary strata ranges from fresh to saline, with an average TDS of 9,427 mg/L and range between 363 and 11,700 mg/L.

In the Rewan Group, groundwater ranges from moderately saline to saline, with an average TDS of 25,126 and range between 19,600 and 30,800 mg/L.

Within the RCM, groundwater ranges from brackish to highly saline, with bores that screen coal seams recording an average TDS of 9,481 and range between 1,000 to 17,000 mg/L, and bores screening interburden/overburden recording average TDS of10,400 and range between 3,250 to 18,500 mg/L.

In the Burngrove Formation, groundwater ranges from moderately saline to saline, with an average TDS of 6,964 mg/L and range between 3,250 and 14,400 mg/L.



Note: n = number of bores

Figure 5-7 Salinity Ranking by Hydrostratigraphic Unit

5.1.3 Beneficial Groundwater Use

5.1.3.1 Potentially Relevant Environmental Values and Guidelines

The Project Area lies mainly within the Highlands Groundwater Management Area (GMA) of the Fitzroy Basin under the *Water Plan (Fitzroy Basin) 2011* (**Figure 5-8**). The Highlands GMA consists of the following:

- Highlands Groundwater Unit 1, containing the aquifers of the Quaternary alluvium associated with the Sandy Creek Alluvium sub-area (to the distant northwest of BWM but not located within the Study Area); and
- Highlands Groundwater Unit 2, containing all subartesian aquifers within the Highlands GMA other than the aquifers included in Highlands Groundwater Unit 1.

Volumetric limits apply to extraction of groundwater within the GMA for non-stock and domestic purposes.

Groundwater resources in the Study Area are also scheduled under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water and Wetland Biodiversity), as Comet Groundwaters (for the southern part of BWM within the Comet sub-catchment (DEHP, 2011a)) and Mackenzie Groundwaters (for the northern part of BWM within the Upper Mackenzie sub-catchment (DEHP, 2011b)) of the Fitzroy Basin water plan (WQ1310) (**Figure 5-8**). The legislated environmental values (EVs) for these Groundwaters (**Table 5-1**) are:

- Aquatic ecosystems;
- Irrigation;
- Farm supply/use;
- Stock water;
- Primary recreation (Comet Groundwaters only);
- Drinking water;
- Industrial use; and
- Cultural and spiritual values.

Also shown in **Table 5-1** is a comparison of those WQOs to potentially applicable based on the results of the EMM (2019) bore census (see **Section 5.2.1**). EMM (2021) concluded that based on the bores that were surveyed in the 2019 bore census *"the environmental values for groundwater in the area are limited to farm supply/use, stock water and industrial use (.ie mining). Aquatic ecosystems may also be associated with shallow alluvial systems" (***Table 5-1**).

Table 5-1 Environmental Values of Comet and Mackenzie Groundwaters of the Fitzroy Basin

Environmental Values (DEHP, 2011a, 2011b)												
Fitzroy Basin Water Plan (WQ1310) Sub-catchment	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human Consumer	Primary Recreation	Secondary Recreation	Visual Recreation	Drinking water	Industrial use	Cultural and spiritual values
Comet Groundwaters	☑	☑	☑	☑			☑			☑	☑	☑
Mackenzie Groundwaters	☑	☑	☑	☑						☑	☑	☑
Potentially Locally Applicable based on EMM (2019) bore census	☑		☑	☑							☑	

The EPP Water and Wetland Biodiversity provides water quality objectives (WQOs) for the scheduled EVs in WQ1310. WQOs are long-term goals for water quality management and the purpose of the WQOs is to support and protect EVs. They are numerical concentration levels or narrative statements of indicators established for receiving waters to support and

protect the designated EVs for those waters. They are based on scientific criteria or water quality guidelines but may be modified by other inputs (e.g. social, cultural, economic).

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

The WQ1310 WQOs for groundwater relevant to BWM are shown **Table 5-2**.

Table 5-2 Water Quality Objectives for Fitzroy Sub-basin Environmental Values

Water Quality Indicator	Unit	ADWG Guidelines[1]		Mackenzie River Sub-basin EVs			Comet River Sub-basin EVs		
		ADWG Guidelines Health	ADWG Guidelines Aesthetic	Irrigation[2]	Stock[3]	Aquatic 95%[4]	Irrigation[5]	Stock[6]	Aquatic 95%[4]
pH	-	-	6.5 to 8.5	-	-	6.5 to 8.5	-	-	6.5 to 8.5
TDS	mg/L	-	600		5000[7]	-		5000[7]	-
Chloride	mg/L	-	250	-	-	-	-	-	-
Sodium	mg/L	-	180	-	-	-	-	-	-
Aluminium	mg/L	-	0.2	5	5	0.055	5	5	0.055
Arsenic	mg/L	0.01	-	0.1	0.5	0.024	0.1	0.5	0.024
Beryllium	mg/L	0.06	-	0.1	-	-	0.1	-	-
Boron	mg/L	4	-	0.5	5	-	0.5	5	-
Cadmium	mg/L	0.002	-	0.01	0.01	0.0002	0.01	0.01	0.0002
Chromium	mg/L	0.05	-	0.1	1	0.001	0.1	1	0.001
Cobalt	mg/L	-	-	0.05	1	-	0.05	1	-
Copper	mg/L	2	1	0.2	1[6]	0.0014	0.2	1[6]	0.0014
Fluoride	mg/L	1.5	-	1	2	-	1	2	-
Iron	mg/L	-	0.3	0.2	-	-	0.2	-	-
Lead	mg/L	0.01	-	2	0.1	0.0034	2	0.1	0.0034
Lithium	mg/L	-	-	2.5	-	-	2.5	-	-
Manganese	mg/L	0.5	0.1	0.2	-	1.9	0.2	-	1.9
Mercury	mg/L	0.001	-	0.002	0.002	0.0006	0.002	0.002	0.0006
Molybdenum	mg/L	0.05	-	0.01	0.15	-	0.01	0.15	-
Nickel	mg/L	0.02	-	0.2	1	0.011	0.2	1	0.011
Selenium	mg/L	0.01	-	0.02	0.02	0.005	0.02	0.02	0.005
Silver	mg/L	0.1	-	-	-	0.05	-	-	0.05
Uranium	mg/L	0.02	-	0.01	0.2	-	0.01	0.2	-
Vanadium	mg/L	-	-	0.1	-	-	0.1	-	-
Zinc	mg/L	-	3	2	20	0.008	2	20	0.008

1. NHMRC (2025) Australian Drinking Water Guidelines
2. Table 9 of DEHP (2011b) Mackenzie River Sub-basin Environmental Values and Water Quality Objectives: Irrigation water (Long term value)
3. Table 10 and Table 11 of DEHP (2011b) Mackenzie River Sub-basin Environmental Values and Water Quality Objectives: Stock value)
4. ANZG (2018) Aquatic ecosystem protection for moderately disturbed system (95% for protection and 99% for bioaccumulating contaminants)
5. Table 9 of DEHP (2011a) Comet River Sub-basin Environmental Values and Water Quality Objectives: Irrigation water (Long term value)
6. Table 10 and Table 11 of DEHP (2011a) Comet River Sub-basin Environmental Values and Water Quality Objectives: Stock value
7. Relevant guideline value for cattle

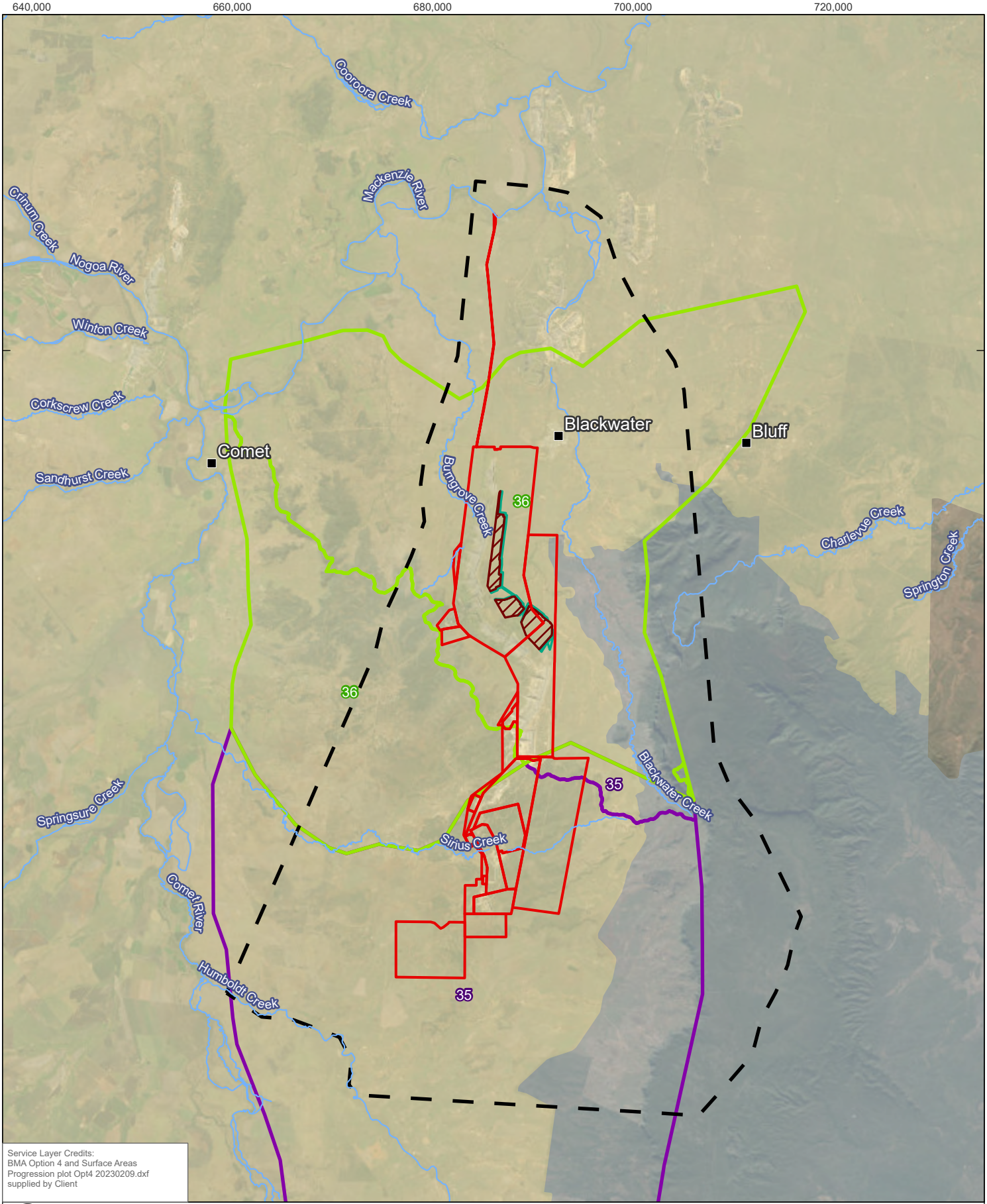


The EPP Water and Wetland Biodiversity also provides limited WQOs specifically for underground aquatic ecosystem protection in Fitzroy Basin groundwaters. These WQOs vary across the Fitzroy Basin and are defined on the basis of groundwater Chemistry Zones. The applicable Chemistry Zones for BWM include the Fitzroy Groundwater Zone 35 and Zone 36 (**Figure 5-8** and **Table 5-3**) which are characterised as sodic dominant at levels of dissolved material that classify general water quality as low to moderate salinity (Zone 36) and saline (Zone 35).

These WQOs are classified by groundwater depth ('shallow' being <30 m depth, and 'deep' being >30 m depth) and are summarised below. The management intent of each WQO zone is to maintain each of 20th, 50th and 80th percentile values.

Table 5-3 Fitzroy Basin Zone 35 and Zone 36 WQOs for groundwater resources (aquatic ecosystem protection) (DEHP, 2011a and 2011b)

Water Quality Indicator	Unit	Zone 35 Shallow Groundwater (<30m)			Zone 35 Deep Groundwater (>30m)			Zone 36 Shallow Groundwater (<30m)			Zone 36 Deep Groundwater (>30m)		
Percentile	-	20th	50th	80th	20th	50th	80th	20th	50th	80th	20th	50th	80th
EC	(µS/cm)	84	870	1983	4103	9375	13604	3100	6300	7410	3475	4150	7255
Hardness as CaCO3	(mg/L)	37	124	430	401	1216	1905	323	363	528	288	354	619
pH	(mg/L)	7.59	7.6	7.93	7.37	7.6	8.01	7.7	7.80	8.35	8.21	8.3	8.66
Alkalinity	(mg/L)	122	320	556	92	189	311	316	600	843	460	572	1322
Ca	(mg/L)	6	14	81	33	146	366	42	53	105	23	45	75
Mg	(mg/L)	3	27	58	45	204	226	46	56	72	44	74	106
Na	(mg/L)	59	113	256	465	1750	2555	590	1404	1511	520	830	1748
Cl	(mg/L)	54	86	392	1079	3316	5368	610	1885	2373	793	1000	1945
SO4	(mg/L)	5	11	25	0	20	122	2	5	120	84	115	210
HCO3	(mg/L)	42	333	646	126	268	376	372	732	1021	541	640	1549
NO3	(mg/L)	0.15	1.4	9.6	0	0.1	0.5	1	4.25	7.50	0.65	2	2.9
SiO2	(mg/L)	43	68	72	9	18	76	25	43	60	32	43	81
F	(mg/L)	0.1	0.2	0.5	0.06	0.3	0.5	0.285	0.3	0.39	0.31	0.4	1.12
Fe	(mg/L)	-	-	-	0	0.01	0.047	0.02	0.02	0.02	0.02	0.02	0.047
Mn	(mg/L)	-	-	-	0.01	0.04	2.495	0.02	0.045	0.07	0.02	0.02	0.047
Zn	(mg/L)	-	-	-	0.01	0.14	0.27	-	-	-	-	-	-
Cu	(mg/L)	-	-	-	0	0.005	0.01	-	-	-	-	-	-



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BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER MANAGEMENT AREAS AND CHEMISTRY ZONES

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FIGURE 5-8

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_F02_01_Groundwater Management Areas and Chemistry Zones

5.1.3.2 Comparison of Groundwater Quality to Potentially Relevant Guidelines

In order to understand the possible utilisation of groundwater resources within the Study Area, given the scheduled EVs discussed above, the available groundwater quality data have been compared to the:

- Australian Drinking Water Guidelines (ADWG) (NRMMC, 2011).
- ANZG (2018) Aquatic ecosystem protection for moderately disturbed system (95% protection).
- Fitzroy Basin Groundwater Water Quality Objectives: Aquatic ecosystems (Zones 35 and Zone 36).
- Mackenzie and Comet River Sub-basin Environmental Values and Water Quality Objectives: stock and irrigation.

A comparison of these guidelines to the 80th percentile of available historical water quality data for each BWM EA monitoring bore is presented as **Appendix A**. A summary of **Appendix A** is provided in **Table 5-4** as the percentage of analysed bores with 80th percentile groundwater quality data above the relevant guideline for one or more analyte. This is further discussed in detail in the below text.

Table 5-4 Percentage of Analysed Bores in Aquifer with 80th Percentile Groundwater Quality Data Above Relevant Guideline for one or more Analyte (refer Appendix A)

Aquifer	Number of bores Analysed	ADWG Guidelines Health[1]	ADWG Guidelines Aesthetic[1]	Irrigation[2]	Stock[3]	Aquatic 95%[4]	80th %ile WQO limit[5]
Alluvium	1	100%	100%	100%	100%	100%	100%
Tertiary	3	100%	33%	100%	100%	67%	100%
Rewan	2	100%	100%	100%	100%	100%	100%
Permian (north)	9	100%	44%	100%	100%	78%	44%
Permian (south)	2	100%	100%	100%	100%	50%	100%
Burngrove Formation	2	100%	50%	100%	50%	50%	100%

1. NHMRC, NRMMC (2011) Australian Drinking Water Guidelines
2. Table 9 of DEHP (2011a) Comet River Sub-basin / Table 9 of DEHP (2011b) Mackenzie River Sub-basin Environmental Values and Water Quality Objectives: Irrigation water (Long term value).
3. Table 10 and Table 11 of DEHP (2011b) Mackenzie River Sub-basin Environmental Values and Water Quality Objectives: Stock.
4. ANZG (2018) Aquatic ecosystem protection for moderately disturbed system (95% protection).
5. Fitzroy Basin Zone 35 and Zone 36 WQOs for groundwater resources (aquatic ecosystem protection) (DEHP, 2011a and 2011b)

Quaternary Sediments

Water quality data from one bore in the alluvium with available data shows that concentrations from most analytes are generally higher than the relevant Fitzroy Basin WQOs for aquatic ecosystem protection. Alluvium groundwater data also indicates it is generally not suitable for supporting the Aquatic Ecosystems EV with respect to copper and zinc. The 80th percentile concentrations of the alluvium data also indicate the alluvial groundwater is generally unsuitable to support the Drinking Water EV with respect to



chloride, sodium and manganese and TDS, the Irrigation EV with respect to boron, manganese and uranium, and the Stock Watering EV with respect to TDS (salinity).

Tertiary Sediments

Groundwater quality data, where groundwater is present in the Tertiary sediments/regolith, shows that collectively it is not considered a suitable groundwater resource for drinking and irrigation due to exceedances above Fitzroy Basin WQOs with respect to beryllium, nickel, lead, fluoride and manganese or TDS and boron, iron, manganese, fluoride and molybdenum respectively (see **Appendix A**). Monitoring data from the Tertiary bores show that analyte concentrations exceed the relevant Fitzroy Basin WQOs for Aquatic Ecosystem protection across all three analysed bores, particularly for dissolved metals (see **Appendix A**). The monitoring data also shows that of the Tertiary bores, only one of two bores showed water quality above the Stock EV guideline with respect to fluoride, aluminium and TDS (see **Appendix A**).

Triassic Rewan Group

Groundwater quality data from two bores screened in the Rewan Group shows that most analyte concentrations are generally higher than the relevant Fitzroy Basin WQOs for Aquatic Ecosystem protection. The data also indicates it is generally not suitable for supporting the Aquatic Ecosystems EV with respect to most relevant metal concentrations (**Appendix A**). The monitoring bore data also suggests that it is generally not suitable for supporting the Drinking Water, Stock, Irrigation EVs (**Appendix A**).

Rangal Coal Measures

As with the Alluvium, Tertiary and Rewan Group, RCM monitoring bore data shows concentrations of most analytes are generally higher than the relevant Fitzroy Basin WQOs for Aquatic Ecosystem protection. RCM monitoring bore data generally suggests that RCM groundwater in the Project Area is unsuitable to support the Aquatic Ecosystems EVs with respect to pH, cadmium, chromium, copper, nickel, lead, selenium or zinc and the Drinking Water EV with respect to selenium, manganese or fluoride (see **Appendix A**). The RCM monitoring bore data also generally suggests that RCM groundwater in the Project Area is also unsuitable to support the irrigation water EV with respect to boron, iron, molybdenum, manganese, selenium or uranium. The monitoring bore data shows water quality generally above the Stock water EV guideline with respect to selenium and TDS (**Appendix A**).

Burngrove Formation

Groundwater quality data is available from two bores screened in the Burngrove Formation namely bores BG No.1 AP and BG No.2 BG located in the north of the Project Area.

Burngrove Formation groundwater data also indicates it is generally not suitable for supporting the Aquatic Ecosystems EV with respect to selenium and nickel. Groundwater does not meet the Drinking Water EV criteria with respect to pH, iron, manganese, sodium, chloride or TDS and the Irrigation EV with respect to boron or iron. The monitoring bore data indicates only one exceedance in TDS at bore BG No.2 BG above the Fitzroy Basin WQOs for Stock Watering.

Summary

In summary, the comparison of available groundwater quality data from the BWM monitoring bores shows that all hydrostratigraphic units at BWM generally exhibit water quality that exceeds some of the relevant parameter criteria for the scheduled EVs.

5.2 Groundwater Receptors

This section reviews the groundwater receptors, both anthropogenic (groundwater bore users) and environmental (GDEs, springs and wetlands).

5.2.1 Anthropogenic

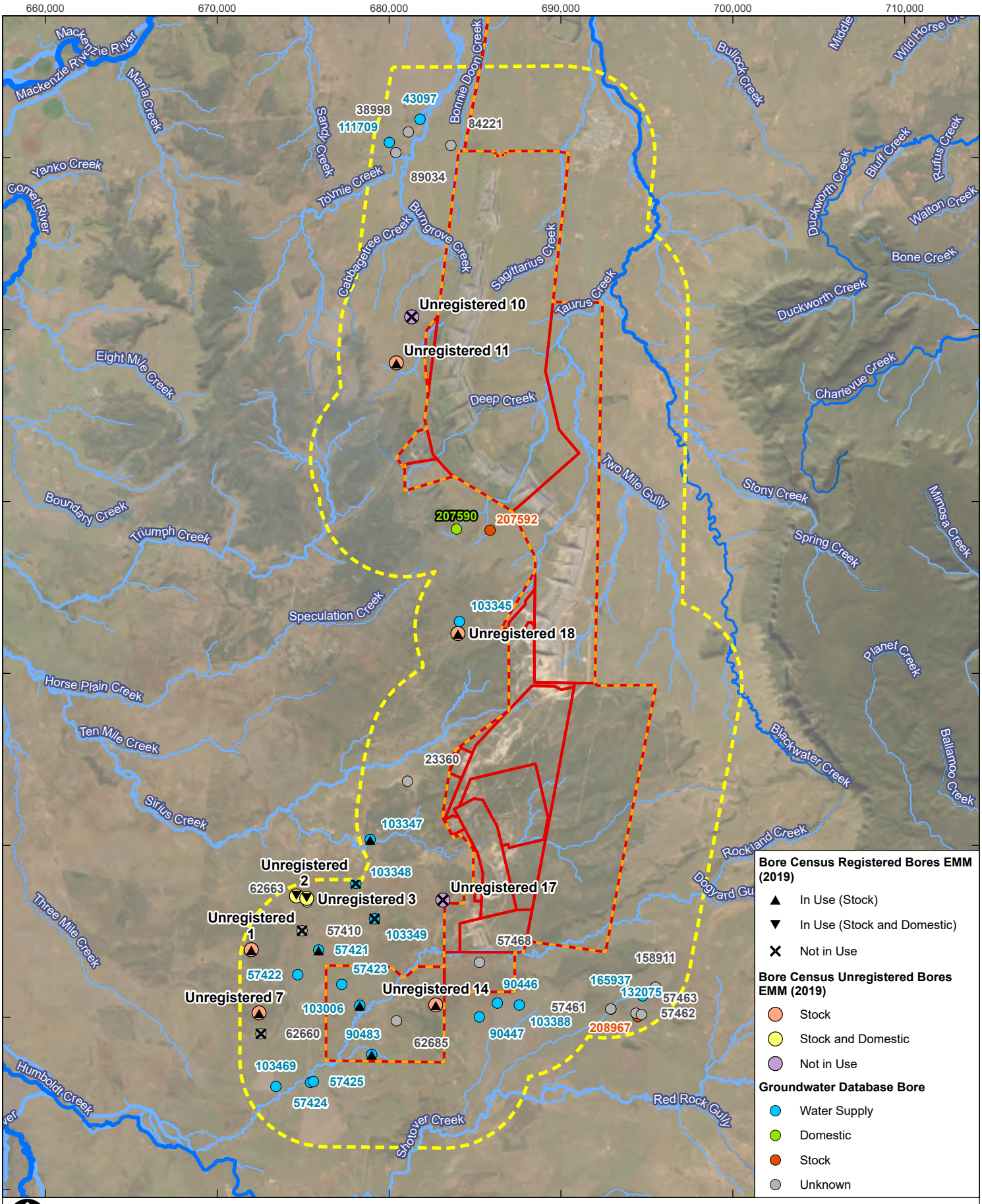
A search of the Queensland Government's Registered Groundwater Bore Database (GWDB) (DRDMW, 2026) was carried out for registered bores within 5 km of the EA boundary. The search returned 315 registered bores.

The landholder bore census conducted at BWM North by EMM (2019) was also reviewed. Within 5 km of the EA boundary a total of 18 bores were visited during the census, including 9 registered bores and 9 unregistered bores (**Figure 5-9**).

The results of the combined registered bore search and review of the available bore census within 5 km of the EA boundary are shown in **Table 5-5**. Overall, the review identified a total of 44 third-party / potential third-party bores, with uses as water supply (19), stock (7), stock and domestic (2), domestic (1), unknown (13) and not in use (2). It should be noted that the uses listed in the table are a result of the combined review (including not in use) and that only 18 of the 44 identified third-party bores within 5 km of the EA boundary have been subject to a bore census. A previous revised bore search undertaken for the BWM North area (see SLR, 2025b) similarly identified some bores in the area had not been subject to a bore census. Given this, it is recommended to conduct a bore census for the remaining third-party bores identified. The objective of conducting a census would be to confirm the bores presence and potential usage (i.e. confirm their status as a potential receptor). It is also acknowledged that additional unregistered bores may be identified through discussions with the landholders as part of the census.

Table 5-5 Results of Combined Registered Bore Search and Available Bore Census within 5 km of EA Boundary

Use	Number	Third Party Bore?
Mine monitoring	238	No
Petroleum exploration	1	No
Sub-artesian monitoring	19	No
Water resource investigation	1	No
Water supply	19	Yes
Stock	7	Yes
Stock and domestic	2	Yes
Domestic	1	Yes
Unknown	13	Potential
Not in use (unregistered private bore)	2	Potential
Decommissioned	21	No
Total (excluding decommissioned)	**315**	


660,000
670,000
680,000
690,000
700,000
710,000
7,390,000
7,380,000
7,370,000
7,360,000
7,350,000
7,340,000
7,330,000
Mackenzie River
Maria Creek
Sandy Creek
Bonnie Doon Creek
Bullock Creek
Middle
Wild Horse Cr
Yanko Creek
Comet River
Tolmie Creek
Cabbagetree Creek
Burngrove Creek
Sagittarius Creek
Taurus Creek
Duckworth Creek
Bluff Creek
Rufus Creek
Walton Creek
Bone Creek
Eight Mile Creek
Deep Creek
Charlevue Creek
Two Mile Gully
Stony Creek
Mimosa Creek
Spring Creek
Boundary Creek
Triumph Creek
Speculation Creek
Planet Creek
Horse Plain Creek
Ten Mile Creek
Blackwater Creek
Ballamoo Creek
Sirius Creek
Rockland Creek
Dogyard Gu
Three Mile Creek
Humboldt Creek
Red Rock Gully
Shotover Creek
43097
38998
111709
84221
89034
207590
207592
103345
Unregistered 18
23360
103347
Unregistered 2
103348
62663
Unregistered 3
Unregistered 17
Unregistered 1
57410
103349
57468
57421
158911
57422
57423
Unregistered 14
90446
165937
132075
57463
Unregistered 7
103006
57461
57462
103388
208967
62660
90483
62685
90447
103469
57425
57424
Unregistered 10
Unregistered 11
Bore Census Registered Bores EMM (2019)
In Use (Stock)
In Use (Stock and Domestic)
Not in Use
Bore Census Unregistered Bores EMM (2019)
Stock
Stock and Domestic
Not in Use
Groundwater Database Bore
Water Supply
Domestic
Stock
Unknown
0
2.5
5
km
LEGEND
Major Watercourse
Minor Watercourse
Project Area (Environmental Authorities boundary)
5 km Buffer – EA Boundary
BWM Mining Lease
Coordinate System: GDA2020 MGA Zone 55
Scale: 1:290,000 at A4
Project Number: 620.041706.00014
Date Drawn: 05-Feb-2026
Drawn by: AS
BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT
THIRD-PARTY BORES WITHIN 5 KM OF EA BOUNDARY
SLR
DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.
FIGURE5-9
Path: H:\Projects-SLR\620-BNE\620-BNE\620.041706.00001 BWM EA Trigger and Network Rev\06 SLR Data\01 GIS\GIS\BWM EA Trigger and Network Review\BWM EA Trigger and Network Review.aprx\620041706_F05_10_Third-Party Bores within 5 km of EA Boundary

5.2.2 Groundwater Dependent Ecosystems

5.2.2.1 National Atlas of Groundwater Dependent Ecosystems

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

The BoM's National Atlas of Groundwater Dependent Ecosystems (GDE Atlas) (BoM, 2017) classifies ecosystems based on the potential for dependence on groundwater through multiple lines of scientific evidence. Ecosystems have been mapped as either:

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

Desktop mapping of potential aquatic and terrestrial GDEs indicates that areas with possible high, moderate, and low potential for groundwater interaction occur in the vicinity of the Project Area (**Figure 5-10**).

Figure 5-10 shows that within the Study Area, approximately 15 km southeast of BWM there are two mapped known GDEs (springs) associated with the Clematis Group outcrop escarpment.

5.2.2.2 Local GDE Studies

Field investigations to verify the groundwater dependence of potential GDEs identified in the BoM GDE Atlas desktop mapping (i.e. ground-truthing investigations) have been undertaken in the vicinity of north BWM by EMM (2023a) for potential TGDEs, and EMM (2023b) for potential aquatic GDEs, E2M Pty Ltd (E2M) (2026) for TGDEs, and DPM Enviroscences Pty Ltd (DPM Enviroscences) (2026) for GDEs. The outcome of these investigations is summarised below. No ground-truthing local investigations have been undertaken in the vicinity of south BWM.

2023 Studies

Field surveys were undertaken that identified and characterised remnant regional ecosystem terrestrial vegetation within the vicinity of north BWM. EMM (2023a) then utilised depth to groundwater table mapping prepared by RDM Hydro et al. (2023) and information on maximum plant rooting depths for the identified vegetation species to assess whether the groundwater table was within the potential rooting depths of the vegetation, and thus if the vegetation may be reliant at least in part on groundwater. **T**he results of the work indicated that the riparian terrestrial vegetation associated with Taurus Creek (a tributary of Blackwater Creek) on the eastern margin of the Project Area and a very small area along Sagittarius Creek to the north of the Project Area may represent a TGDE. The terrestrial vegetation in this area consists of narrow linear communities that fringe the creek, with potential TGDE vegetation types consisting primarily of poplar box (*Eucalyptus populnea*), forest red gum *(Eucalyptus tereticornis*), or river red gum (*E. camaldulensis*) (EMM, 2023a).

Assessments to verify mapped potential aquatic GDEs include the field survey undertaken by EMM (2023b) in the vicinity of BWM North. The outcome of this survey is summarised by EMM (2023b) in the Aquatic Ecology Baseline Assessment Report as:

"Prolonged dry conditions in the lead-up to the December 2019 surveys provided ideal conditions for identifying surface expressions of groundwater (i.e. aquatic GDEs). However, no flows, salt seeps, hydrophytes, or other obvious indicators of aquatic GDEs were encountered. Further, the concentration and relative proportion of major anions and cations in surface water samples collected from the survey area in December 2019 and May 2020 showed no obvious groundwater influence. Field verification of riparian vegetation and aquatic habitats of the survey area found no obvious on-ground indicators of aquatic GDEs."

That is, the field verification of aquatic habitats in the vicinity of north BWM found no indicators of aquatic GDEs (EMM, 2023b) indicating that the BoM GDE Atlas mapping of potential GDEs in this area is potentially erroneous.

2026 Studies

DPM Environsciences completed an assessment in early 2026 to describe the aquatic values of the Project Area (the Study Area – being the BWM North region), identify any conservation significant species under the EPBC Act and Queensland *Nature Conservation Act 1992*, identify the potential for GDEs to occur, identify and describe any aquatic Matters of State or National Environmental Significance, assess impacts of the Project on aquatic and GDE values. The assessment of GDEs concluded:

"*Terrestrial GDEs occur within the Study Area in part of the riparian corridor of Taurus Creek. There is no evidence of surface expression or subterranean GDEs within the Study Area, both of which are unlikely to occur. The presence of stygofauna in an aquifer would indicate a subterranean GDE; however, no stygofauna were detected from five bores and five micropiezometers sampled as part of a pilot survey in both July and October 2025, and there is no evidence of stygofauna having previously been detected from within 5 km of the Study Area*" (DPM Environsciences, 2026).

This study generated the most up-to-date and comprehensive mapping of GDEs within the Study Area and this mapping has been adopted for the GDE assessments in the BWM North region herein.

E2M completed a Terrestrial Ecological Assessment including a further review of TGDEs within the Study Area based on the outcomes of the DPM Environsciences (2026) study. Preliminary desktop assessments identified potential TGDEs in the central extent of the Study Area around Taurus Creek, via the BoM GDE mapping, as previously identified. A field assessment of potential TGDEs defined by DPM Environsciences (2026) concluded the following:

"Based on the species composition of these communities, areas of these REs potentially access groundwater during dry periods, given the presence of E. coolabah and E. populnea, which can be facultative groundwater dependent species (Eamus et al., 2006; Kath et al., 2014; Roberts & Marston, 2000). Remnant vegetation on Two Mile Gully and further upstream on Taurus Creek is unlikely to constitute terrestrial GDEs as they generally contained species that do not represent ground-water dependent vegetation such as Acacia harpophylla and Terminalia oblongata. These species typically have a horizontal root system and are considered unlikely to be dependent on access to groundwater for long-term survival (DES, 2017)" (E2M, 2026).

Areas of TGDEs identified in BWM North are depicted in **Figure 5-10** (based on DPM Environsciences, 2026).

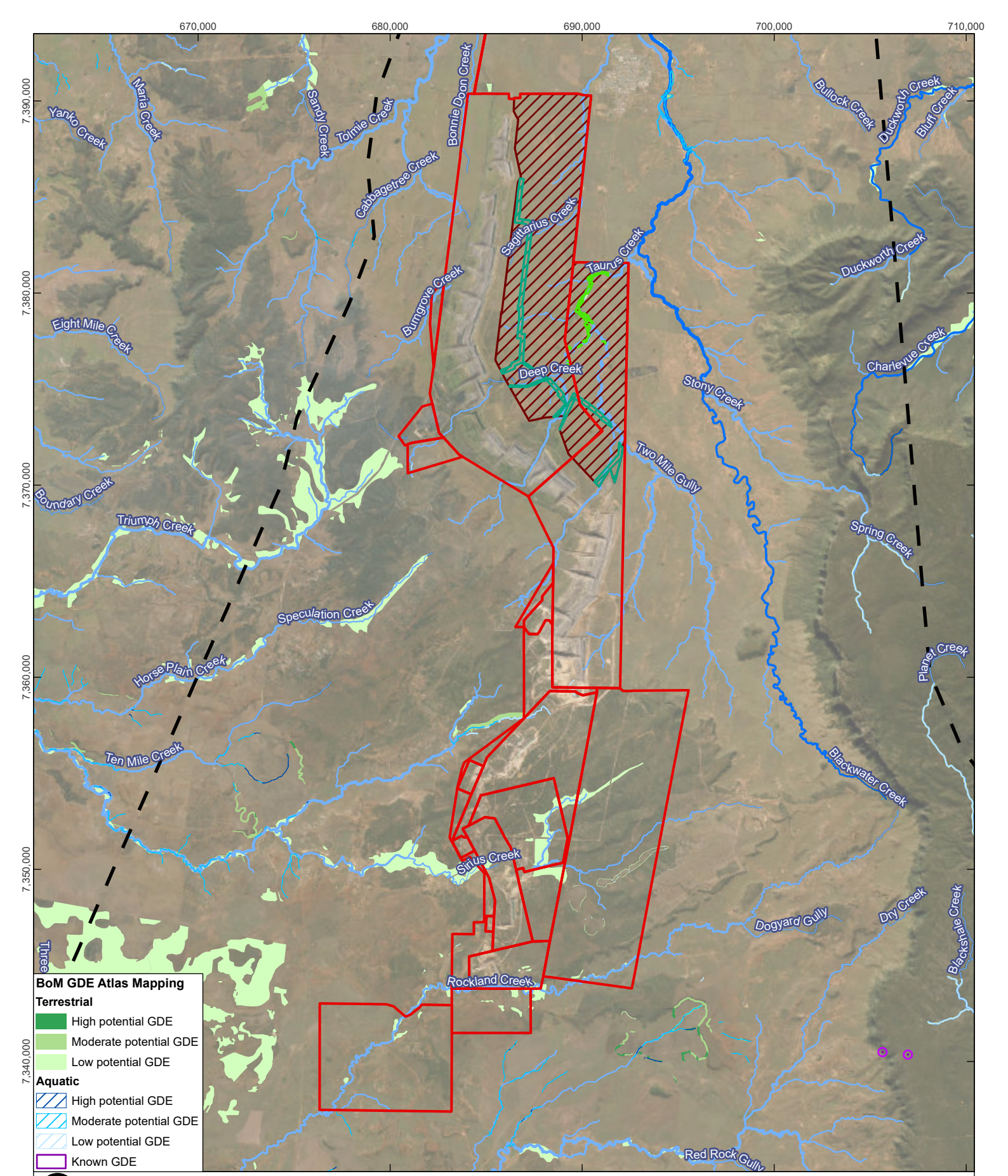
5.2.3 Springs

A search with the QSpatial Database showed that there are no registered springs within a 10 km buffer of the Project Area. The closest registered spring is located approximately 14.8 km southeast from the Project Area, a distance considered significant in the context of

the Project's potential groundwater related impacts such that this spring is not relevant to the Project's impact assessment.

5.2.4 Wetlands

A wetlands search was conducted using data downloaded from the QSpatial Catalogue. The downloaded dataset shows High Ecological Significance (HES) wetlands that are matters of state environmental significance. The dataset did not show any wetlands within a 10 km buffer of the Project Area. The closest wetland is located approximately 19.7 km southeast from the Project Area, a distance considered significant in the context of the Project's potential groundwater related impacts such that this wetland is not relevant to the Project's impact assessment.



Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	07-May-2026
Drawn by:	AS

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER DEPENDENT ECOSYSTEM MAPPING

SLR

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FIGURE 5-10

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F05_10_Groundwater Dependent Ecosystem Mapping

6.0 Conceptual Site Models – End of Mining

A conceptual hydrogeological model (CHM) of the groundwater regime has been developed based on the review of the hydrogeological information for the Study Area presented in the above report sections. The CHM of the groundwater regime is discussed in the below sections as general (**Section 6.1**) and end of mining (**Section 6.2**)

Visual representations of the CHM for the groundwater regime have been developed based on the hydrogeological data review presented above. CHMs have been developed showing the end of mining at north BWM (**Figure 6-1**) and the end of mining at south BWM (**Figure 6-2**).

6.1 General

The Project is located within the southern part of the Bowen Basin, which comprises Permian aged coal measures that have been folded into a syncline structure that strikes in a north-west to south-east direction.

The main hydrostratigraphic units relevant to the Study Area include:

- Alluvium – Alluvial deposits are associated with local creeks. In recent years, the alluvium local to the Project Area has been found to be limited in extent, and dry. The alluvium forms a localised unconfined aquifer where saturated water levels (i.e. the water table) is above the base of the alluvium
- Tertiary Sediments and Basalt –- Unconsolidated surface layer of weathered rock (also termed regolith) including Tertiary strata and basalt flows, which may provide a preferential flow pathway for groundwater if the groundwater table exceeds the base of weathering. The unit forms an unconfined aquifer when saturated.
- Clematis Group – Forms an unconfined aquifer where it outcrops at the eastern margin of the Study Area.
- Rewan Group – Considered a regional scale aquitard, however local permeability testing indicates hydraulic conductivity values may be higher in the upper weathered zone of the unit.
- Rangal Coal Measures – Coal seams of this unit form the primary regional aquifer. Groundwater flow is primarily within the coal seams (via interconnected cleats and fractures), which are confined by low permeability overburden and interburden that essentially form aquitards. The coal measures are highly locally faulted resulting in “compartmentalisation” with coal seams juxtaposed against lower permeability interburden.
- Burngrove Formation – Coal seams of this unit form a regional scale aquifer in conjunction with low permeability overburden and interburden that essentially form aquitards. Considered the basement formation for the purposes of this assessment.

The alluvium is often found to be limited in extent and thickness, and unsaturated, but may become temporarily saturated following rainfall recharge and occasional seepage from ephemeral creek streamflow. Groundwater levels in the unconfined alluvium, where saturated, are expected to be a subdued reflection of topography, with flow toward the north at north BWM and towards the southwest at south BWM. In rare occasions where the alluvium is found to be saturated, groundwater is predominantly restricted to the coarser grained alluvium (that can more easily transmit water). The coarser grained areas of alluvium are separated by clay lenses and outcropping bedrock, with limited connectivity between areas of saturated alluvium. The alluvium is considered to be recharged predominantly via occasional ephemeral stream flow (i.e. losing conditions), or via flooding.

Recharge to the alluvium also occurs via direct rainfall infiltration which occurs rapidly where there are no substantial clay barriers in the shallow subsurface. Overall, recharge is expected to be low due to the presence of surficial clays. On a regional scale, outflow occurs via evapotranspiration from vegetation growing along creek beds. Minor short duration baseflow events after significant rainfall/flooding are possible, however there was no data available to support or reject this hypothesis. Despite extensive drilling targeting the alluvium, groundwater quality data is only available from one alluvium monitoring bore (due to limited extent of the alluvium and areas of saturation where it exists). Data from this bore suggests that water quality in the alluvium ranges from moderately saline to saline and is generally unsuitable to be used for drinking water, stock, or irrigation purposes.

Within the Tertiary units, the strata is typically unsaturated at north BWM but saturated in the south BWM area. Similar to the alluvium, groundwater flow in the Tertiary units is expected to be controlled by topography and flow towards the north at north BWM (where present), and towards the southwest at south BWM. As per the alluvium, recharge to the Tertiary strata is expected to be low due to the presence of overlying clays. Outflow from the Tertiary aquifer is considered to be primarily through evapotranspiration and leakage to underlying aquifers. Water quality data for the Tertiary units is highly variable, ranging from fresh to saline, but generally indicates that Tertiary groundwater is unsuitable to be used for drinking water or irrigation purposes, while the water quality data from three of the four bores in the suggested suitable use for stock water purposes.

The Rewan Group is considered a regional scale aquitard, though still contains some saturated horizons. Due to its typically fine grained nature, the Rewan Group generally exhibits a low vertical hydraulic conductivity, resulting in limited hydraulic connection between the unit and the underlying/overlying units. Groundwater level data from the four saturated monitoring bores grouped in the northern area of BWM indicates a groundwater flow direction towards the north, which is consistent with topographical gradients. Groundwater flow in the Rewan Group in the southern portion of BWM is also expected to follow topography, with a flow direction towards the south and southwest. Recharge is expected to occur predominantly via leakage from the overlying units. Recharge rates are likely very low due to the low hydraulic conductivity of the unit restricting infiltration. Outflow is expected to occur via lateral flow, with the low hydraulic conductivity limiting significant leakage to underlying units. Water quality in the Rewan Group ranges from moderately saline to saline and is indicated to be generally unsuitable to be used for drinking water, stock, or irrigation purposes.

The RCM forms the main regional aquifer in the Study Area. Within the RCM, coal seams form the main groundwater bearing units, with low hydraulic conductivity interburden generally confining the individual seams. The coal seams are dual porosity in nature, with the 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. Due to the confining nature of the interburden layers, flow is primarily horizontal through the coal seams, and recharge primarily occurs where the unit sub-crops. Outflow primarily occurs through inflow to active mining areas. To a much lesser degree, outflow also occurs through horizontal flow outside of the cone of depression formed by mining voids. Groundwater flow direction in the RCM in the vicinity of mining is towards the mine pit voids, consistent with discharge to the active mine pits.

Across the parts of BWM south that are unmined to date, flow direction is south to southwest, with a groundwater divide evident consistent with the surface catchment divide that runs between central and south BWM. Groundwater quality in the RCM ranges from brackish to highly saline and is generally indicated to be unsuitable for drinking water or irrigation purposes, while the water quality data from just over half of the bores suggested suitable use for stock watering purposes.

Groundwater occurrence in the Burngrove Formation is similar to the RCM, with coal seams forming the main aquifer in conjunction with low permeability overburden and interburden that essentially form aquitards. Based on the limited available data, groundwater flow direction in the Burngrove Formation is suggested to be from south to north at BWM north and north to south at BWM south (i.e. consistent with topography). Recharge to the Burngrove Formation is expected to occur where the unit outcrops along the western margin of the Project Area. Outflow from this formation is expected to be through lateral flow in the direction of regional groundwater flow, with some upwards leakage to the depressurised RCM. Groundwater quality is suggested to range from moderately saline to saline and is generally indicated to be unsuitable for drinking water, stock, or irrigation purposes.

6.2 End of Mining

A visual representation of the end of mining conceptual hydrogeological model is provided as **Figure 6-1** for the northern area of BWM and **Figure 6-2** for the southern area of BWM. These are generalised conceptual diagrams to indicate the likely encountered hydrogeological processes,

Based on an understanding of hydrogeological mechanisms and previous studies by SLR (2025a and 2025b), key features relevant to the discussion of potential groundwater impacts post-mining are likely to be:

- Groundwater level drawdown of the RCM, associated with passive dewatering into the active BWM mine pit voids. The magnitude of this drawdown will be most significant in the immediate vicinity of the pits, but extend northwards, eastwards and southwards of BWM by several kilometres.
- Mine pit voids capture any seepage from soil emplacements due to the hydraulic gradient orientated towards the mine void.
- Limited potential for groundwater level drawdown in the alluvium and Tertiary due to limited saturation, and poor lateral connection of water bearing zones.
- No groundwater level drawdown of the alluvium away from BWM.
- Limited potential for groundwater level drawdown impacts to potential terrestrial GDE’s due to the limited potential for groundwater level drawdown in the alluvium and Tertiary.
- No potential for groundwater quality impacts outside of BWM associated with spoil dumps, due to the inward groundwater flow gradients towards the pit voids capturing all potential seepage.

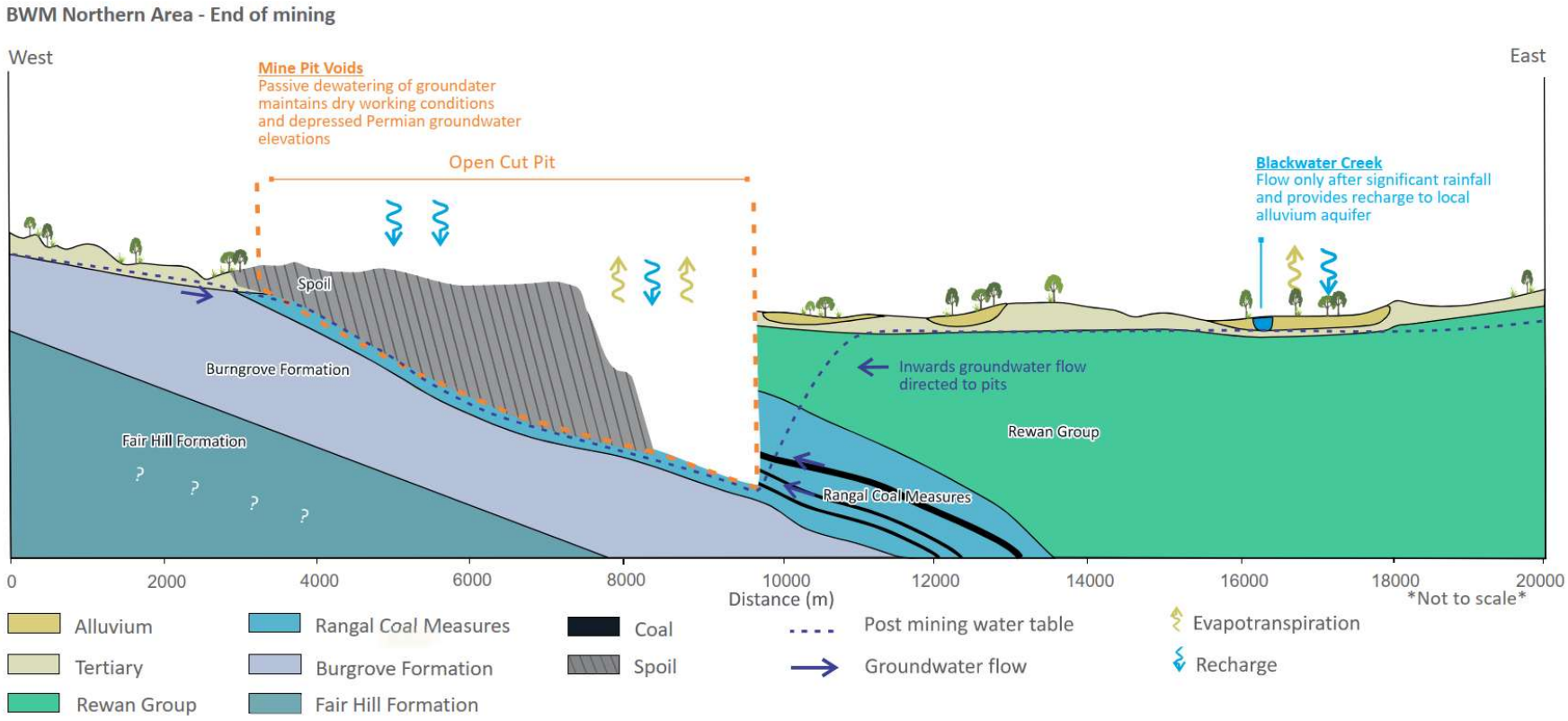


Figure 6-1 Conceptual Hydrogeological Model of BWM Groundwater System – General for BWM Northern Area (End of Mining)

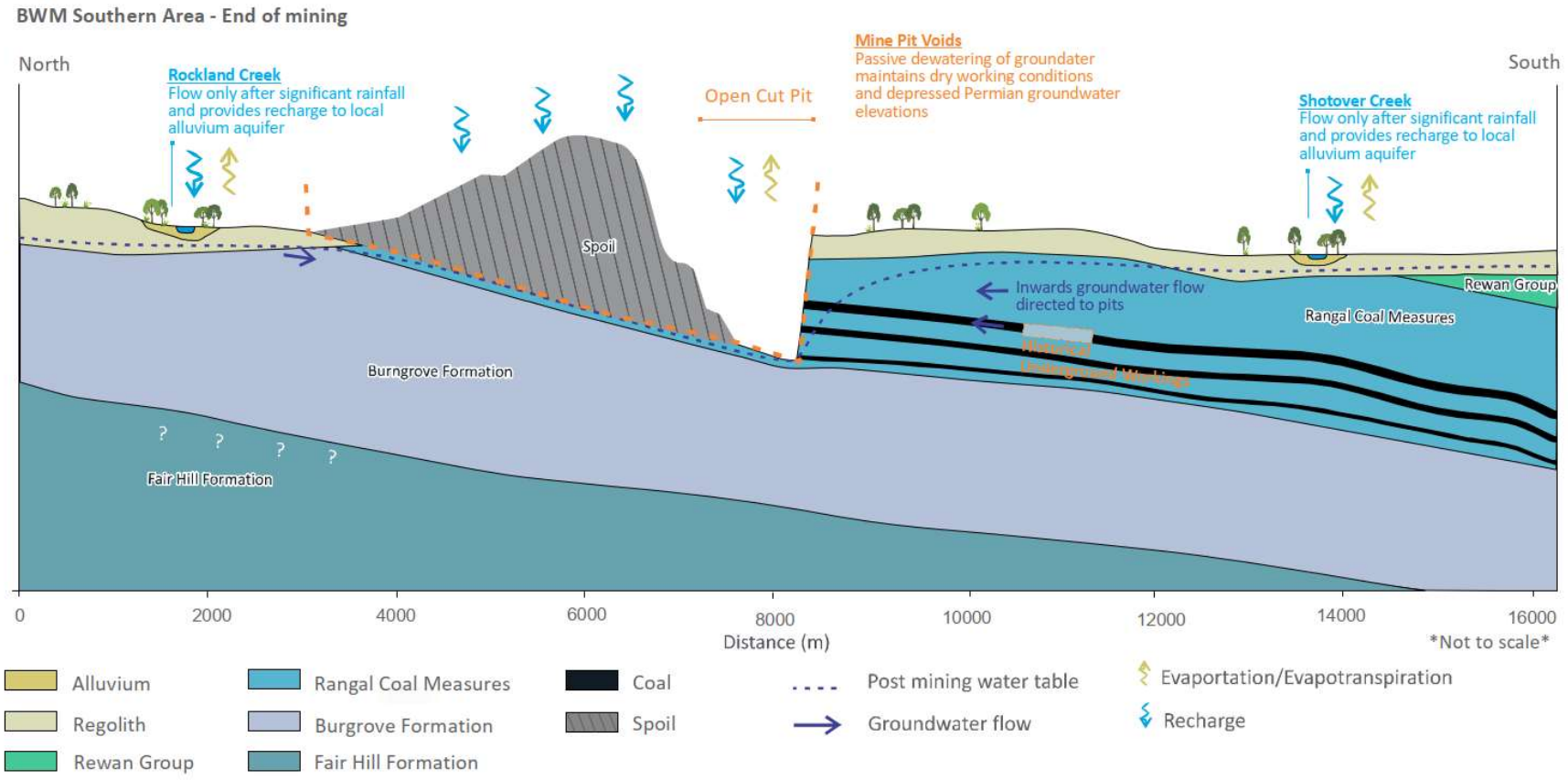


Figure 6-2 Conceptual Hydrogeological Model of BWM Groundwater System – General for BWM Southern Area (End of Mining)

7.0 Potential Impacts

7.1 Groundwater System at End of Mining

The SLR (2026a and 2026b) work has been interrogated to provide an indication of the predicted nature of the groundwater system at the end of mining, and potential groundwater system impacts that may arise at the end of mining.

These can be summarised as:

- Groundwater level drawdown of the RCM, associated with passive dewatering into the active BWM mine pit voids. The magnitude of this drawdown will be most significant in the immediate vicinity of the pits, but extend northwards, eastwards and southwards of BWM by several kilometres.
- Mine pit voids capture any seepage from spoil emplacements due to the local hydraulic gradient orientated towards the mine voids.
- Limited potential for groundwater level drawdown in the alluvium and Tertiary strata due to limited saturation, and poor lateral connection of water bearing zones.
- No groundwater level drawdown of the alluvium away from BWM.
- Limited potential for groundwater level drawdown impacts to potential terrestrial GDE's due to the limited potential for groundwater level drawdown in the alluvium and Tertiary strata.
- No potential for groundwater quality impacts outside of BWM associated with spoil dumps, due to the inward groundwater flow gradients towards the pit voids capturing all potential seepage.

7.2 Groundwater System Post Mining

SLR (2025a) conducted a post-mining assessment of the BWM final voids. The results of the assessment can be considered indicative of the potential impacts to the groundwater system in the post-closure period as relevant to this hydrogeology assessment, that will be investigated further by adopting the updated final landform for all of BWM consistent with the PRC Plan. The post-closure predicted groundwater system documented in the earlier work by SLR (2025a) can be summarised as:

- Residual void lake formation, with lake levels stabilising significantly below the pre-mining groundwater elevations and any shallow post-Permian strata, including the base of surficial weathering and shallow hydrostratigraphic units (i.e. alluvium and Tertiary strata).
- Partial groundwater system recovery outside the residual voids, primarily in the RCM. Ongoing groundwater discharge to the residual 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 lakes keeping the residual void lakes as groundwater sinks.
- Potential for ongoing salinisation of the residual void lakes.
- No potential for groundwater quality impacts outside of BWM associated with spoil dumps, due to the inward groundwater flow gradients towards the residual voids continuing to capture all potential seepage.

The remainder of this report focuses on the detailed assessment of the PRC Plans final landform, i.e. an update to the SLR (2023a) post-mining potential impacts discussed above.

8.0 Groundwater Modelling

The potential post-closure groundwater impacts relevant to Revision 3 of the PRC Plan have been assessed using numerical groundwater modelling as described in the following sections.

8.1 Model Details

The BWM regional numerical groundwater model (the Model) was updated and recalibrated for Revision 2 of the PRC Plan. Further refinement and update was undertaken throughout the Blackwater North Extension Project, as described in the associated Modelling Technical Report (SLR, 2026b) provided here as **Appendix B**.

8.2 PRC Plan Landform 4.1 Model

8.2.1 Model Setup

The Model timing was extended to simulate approved mining until 2094 and simulate the post-mining landform from 2094 until post mining equilibrium. The post mining period in the model extends for 1,946 years (**Table 8-1**).

Table 8-1 Post Mining Model Stress Periods

Stress Period	Duration (years)	Starting Year	Ending Year
155	1	2094	2094
156	1	2095	2095
157	1	2096	2096
158	1	2097	2097
159	1	2098	2098
160	1	2099	2099
161	1	2100	2100
162	1	2101	2101
163	1	2102	2102
164	1	2103	2103
165	1	2104	2104
166	1	2105	2105
167	1	2106	2106
168	1	2107	2107
169	1	2108	2108
170	1	2109	2109
171	1	2110	2110
172	10	2111	2120
173	20	2121	2140
174	100	2141	2240

Stress Period	Duration (years)	Starting Year	Ending Year
175	100	2241	2340
176	100	2341	2440
177	100	2441	2540
178	100	2541	2640
179	100	2641	2740
180	100	2741	2840
181	100	2841	2940
182	100	2941	3040
183	100	3041	3140
184	100	3141	3240
185	100	3241	3340
186	100	3341	3440
187	100	3441	3540
188	100	3541	3640
189	100	3641	3740
190	100	3741	3840
191	100	3841	3940
192	100	3941	4040

8.2.1.1 Predictive Mining

Mining activities were simulated in the predictive model as an extension of the calibration period (i.e. same model setup but different areas being mined though to completion of mining). A detailed description of how mining was simulated in the model for the calibration period is provided in SLR, 2026b, with future mining simulated in the same manner.

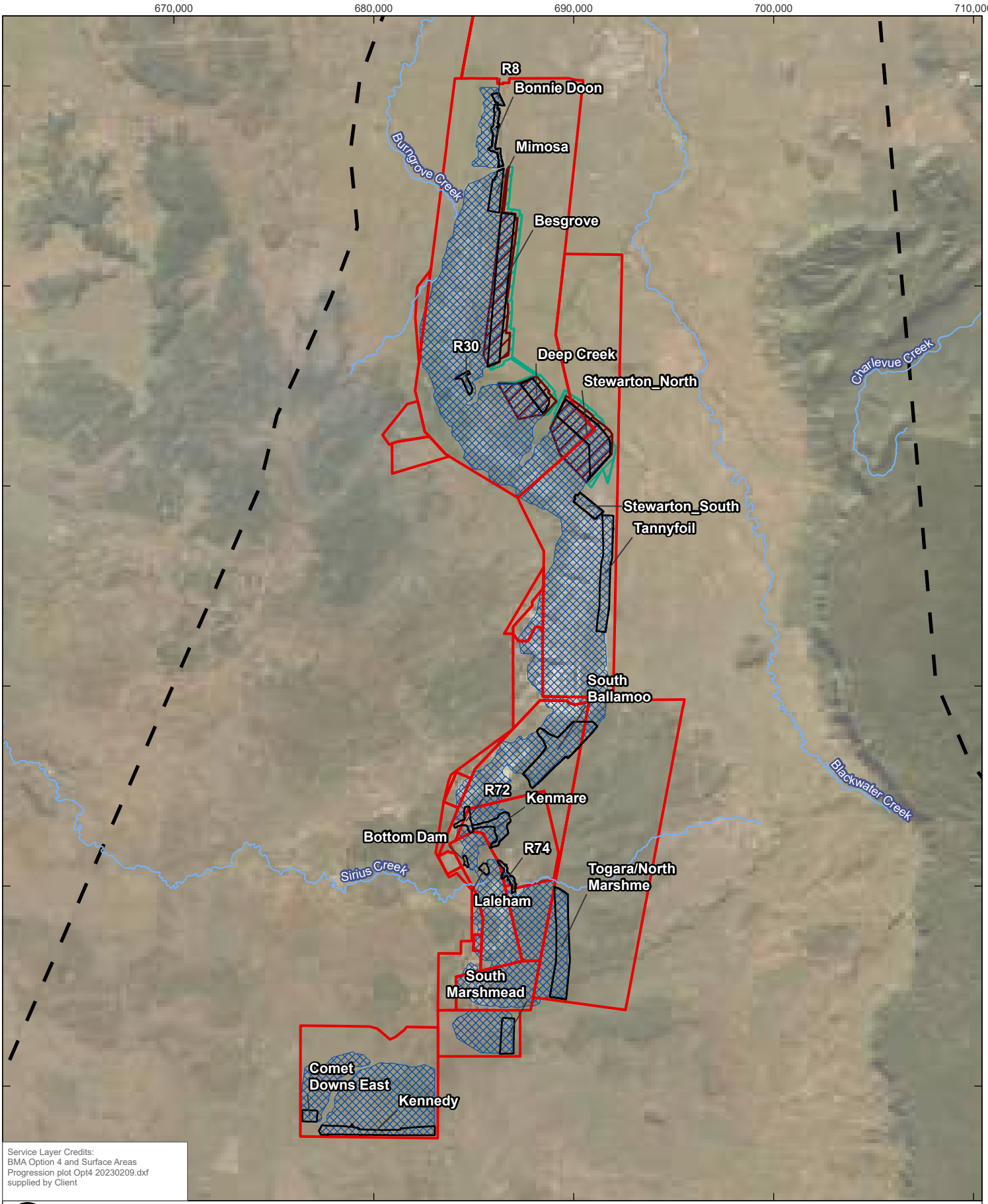
8.2.1.2 Predictive Post Mining

The PRC Plan's proposed final landform 4.1 was replicated in the post mining period of the model, including areas of spoil emplacement within mined out pits, the 15 proposed residual voids, and the three in-pit tailings emplacements at Bonnie Doon, Kenmare and Ramp 74. The distribution of modelled spoil emplacement is shown on Figure 8-1.

In the post mining period of the groundwater model, drain cells simulating the mining pits at BWM are removed to allow groundwater levels to equilibrate. The heads at the start of the post mining period for each relevant hydrostratigraphic unit are provided in **Appendix C**.

Climate related boundary conditions (i.e. recharge and evapotranspiration [ET]) in the post mining period were set constant, at their values consistent with stress period 1 of the model (i.e. long term average, refer to SLR, 2026b). Recharge and ET were not applied to the final voids (or associated in-pit tailings emplacements) themselves in the groundwater model, since the water balance model used iteratively with the groundwater model (see **Section 8.2.2**) accounts for these boundary conditions.

At the end of mining at BWM, the properties of the final void cells were converted to values representative of a void. The void cells were assigned high horizontal and vertical hydraulic conductivities (1,000 m/day) and storage parameters based on the compressibility of water (specific yield of 1.0, storage coefficient of 5.0×10^{-6} m^{-1}), to simulate free water movement within the final void. This approach is often referred to as a 'high-K' lake.



Service Layer Credits:
BMA Option 4 and Surface Areas
Progression plot Opt4 20230209.dxf
supplied by Client

0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	06-May-2026
Drawn by:	AS

LEGEND

- Watercourse
- BWM Mining Lease
- GIA Study Area
- Spoil Extent
- Void Extent
- Proposed Infrastructure Area
- Proposed Open Cut Extension

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

SIMULATED SPOIL EMPLACEMENT

SLR

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FIGURE 8-1

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F08_01_Simulated_Spoil_Emplacement

8.2.2 Integration with Residual Void Water Balance

Figure 8-2 presents a conceptual diagram of the post-mining modelling setup adopted for this hydrogeological assessment. As shown in **Figure 8-2,** the residual voids will accumulate water over time due to direct rainfall, surface water runoff and groundwater inflow from both spoil and natural rock as groundwater levels recover. Whilst the numerical groundwater model can reliably account for the groundwater inflow component, the surface components of direct rainfall, surface water runoff, as well as evaporative loss from the void lake, are considered to be better accounted for within a surface water balance model. This is due to the inherently more refined nature of simulating those surface components within a water balance model, as compared to a numerical groundwater model.

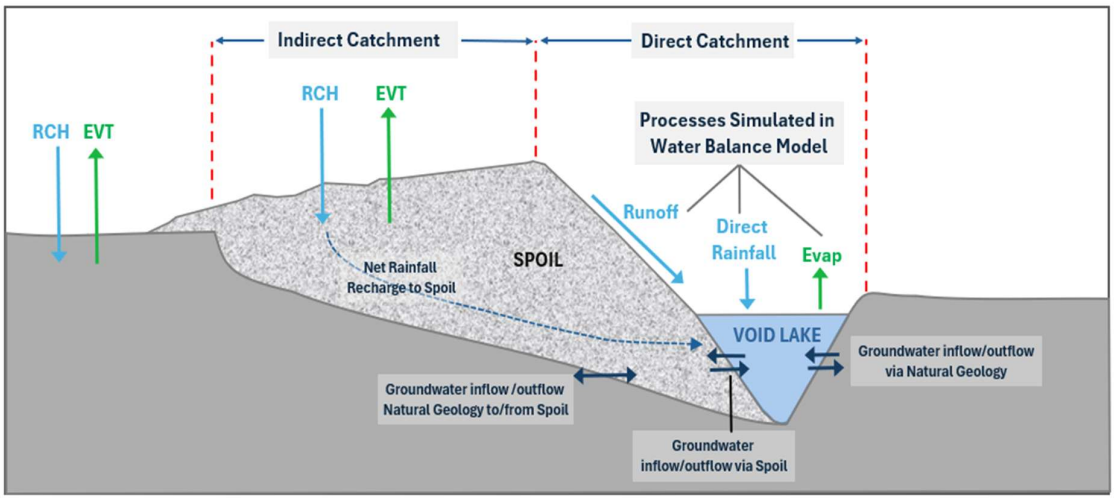


Figure 8-2 Residual Void Recovery Model Conceptual Diagram

The groundwater model was therefore used to predict the following fluxes to the residual voids:

- Groundwater inflow to the pit shell from the surrounding geology, including inflow from the natural geology to the spoil backfill and inflow from the natural geology directly to the residual voids; and
- Groundwater inflow originating from the indirect catchment (i.e. areas of spoil backfill that receive rainfall recharge that then flows through the spoil into the residual voids).

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.

The following methodology was used to allow convergence between the groundwater and water balance models with respect to void lakes. The groundwater modelling methodology involves a stepwise iterative process with the water balance model:

1 Initial predicted groundwater inflows with time to the voids from the groundwater model were incorporated in the initial water balance model.

2 The pit lake recovery levels and timings were then predicted by the water balance model, incorporating both groundwater and surface water fluxes and processes.

3 The void water elevations and recovery timings derived from the water balance modelling were then replicated within the numerical groundwater recovery model

using the time variant constant head boundary (CHD) condition, to refine the groundwater model prediction of void groundwater inflows and lake recovery.

4 Assessment was made to check that the refined groundwater model predictions for fluxes to the voids agree with what was used as input to the water balance modelling.

To avoid iterating many times between the groundwater model and the water balance model before reaching agreement, SLR used an automated process (using python code) that iterates between the groundwater model and the water balance model until a predefined convergence criteria is reached (Xiao et al., 2025). Not only does this automated process save time, it also allows reaching full convergence between the groundwater and the water balance model, increasing confidence in the modelling process.

8.2.3 Residual Void Lake Recovery

Figure 8-3 through **Figure 8-17** provide a graphical representation of the final simulated recovery of water levels in the residual voids for the year 2094 onwards, based on the iterative groundwater and surface water balance modelling. As mining activity ends in different years for each void prior to the closure year of 2094, the duration over which residual void lake levels recover in the plots is variable.

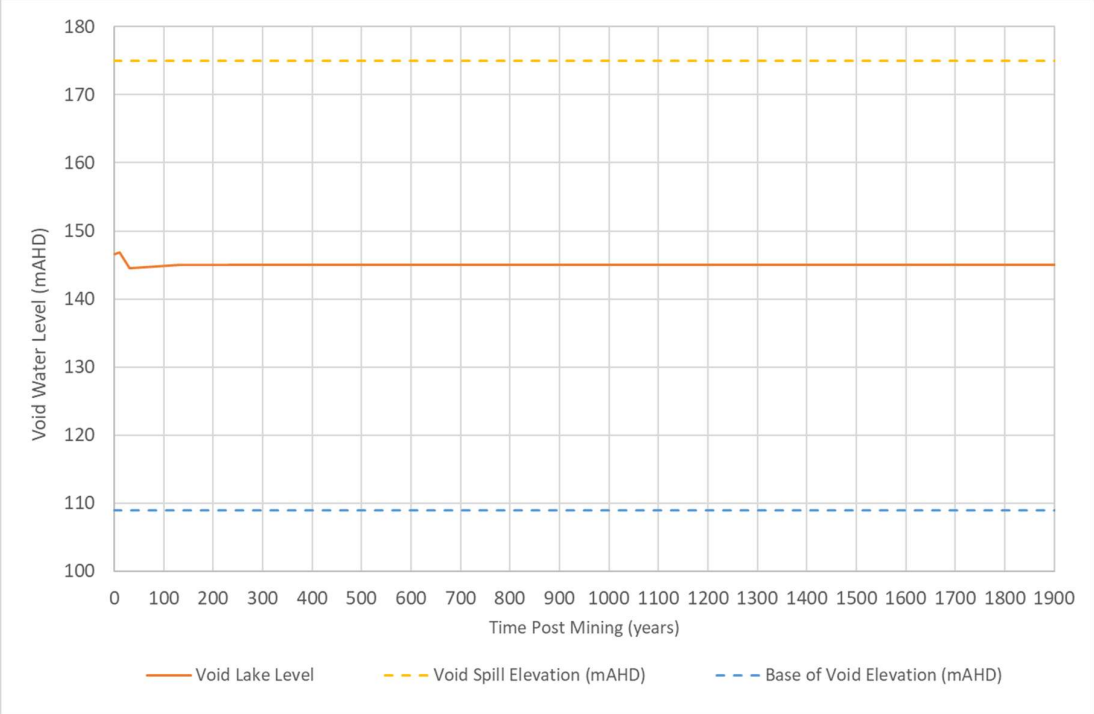


Figure 8-3 Simulated Void Water Level Recovery – Ramp 8

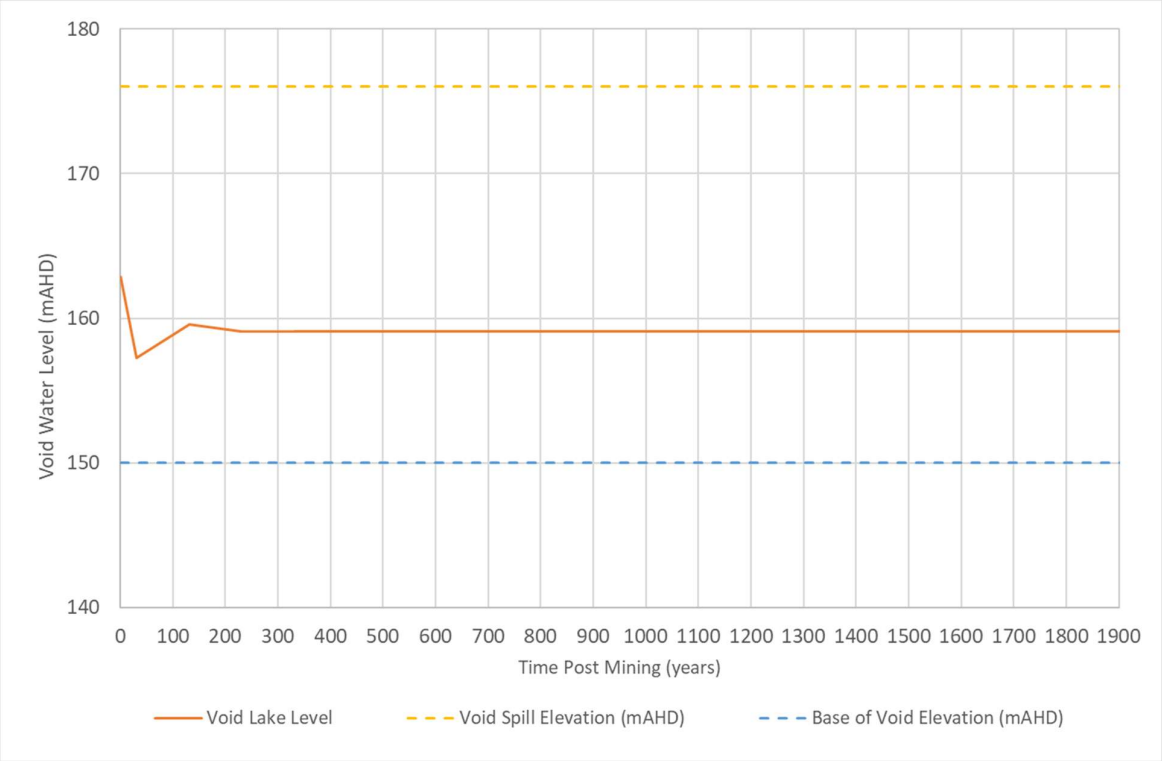


Figure 8-4 Simulated Void Water Level Recovery – Bonnie Doon

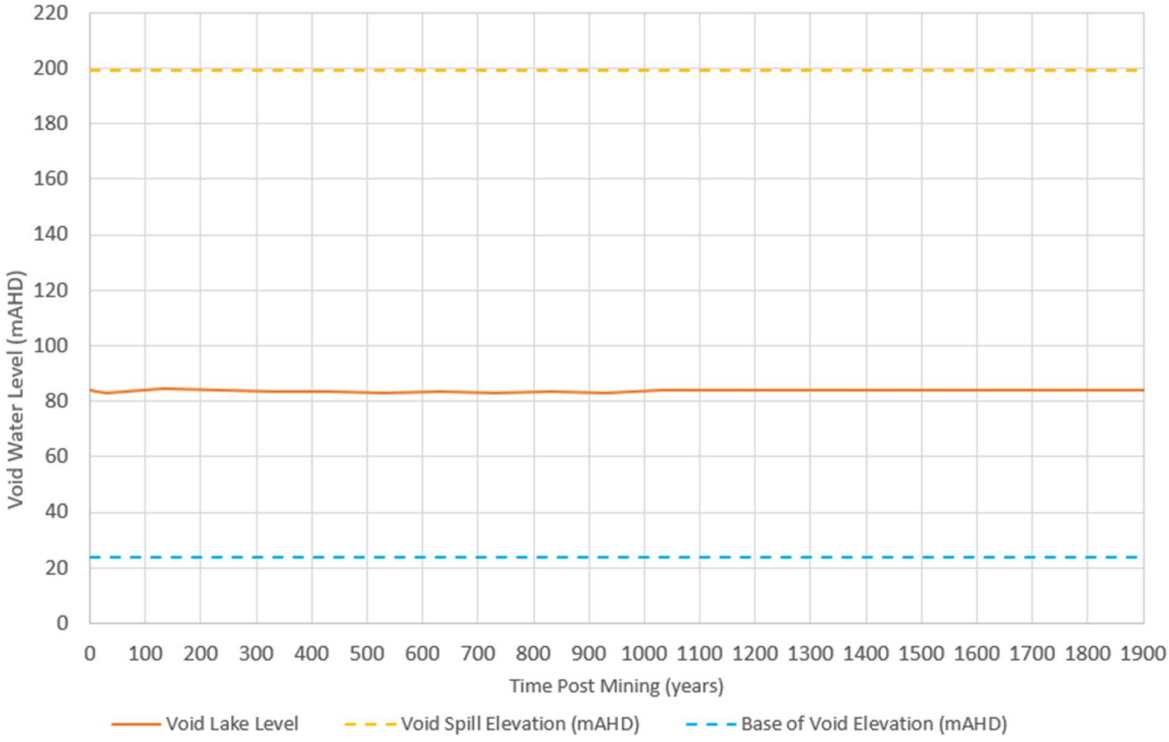


Figure 8-5 Simulated Void Water Level Recovery – Mimosa/Besgrove

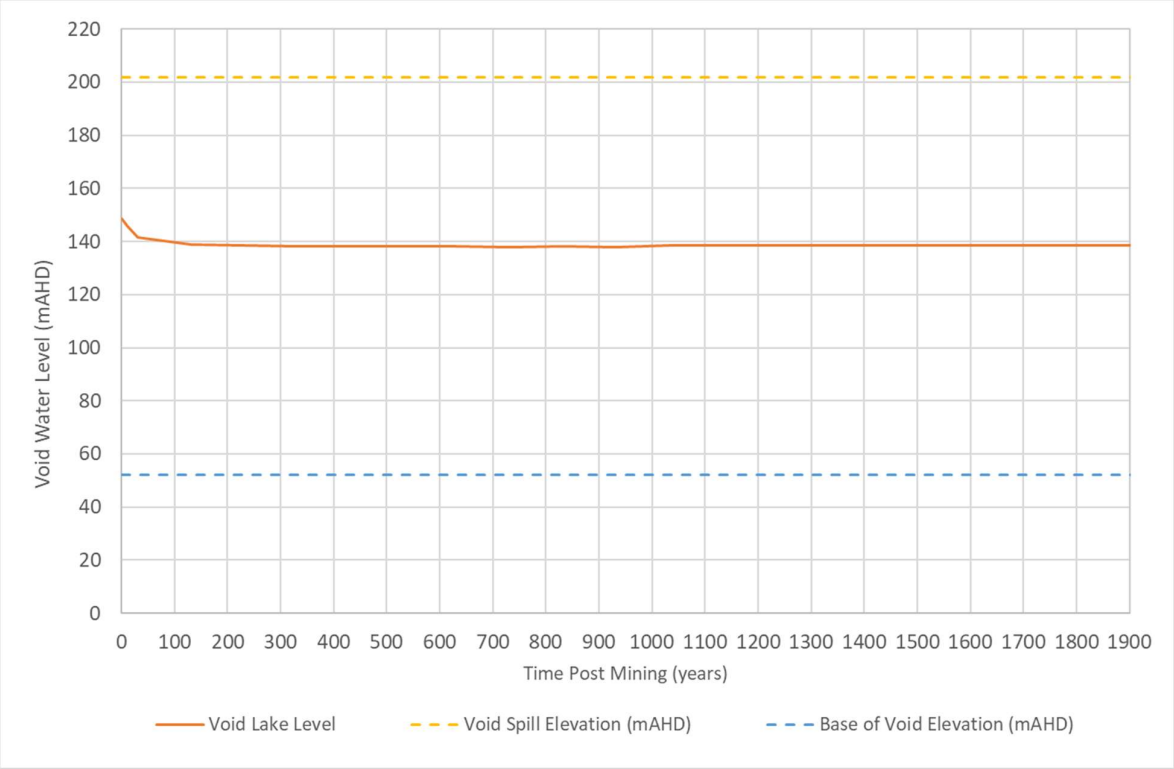


Figure 8-6 Simulated Void Water Level Recovery – Deep Creek

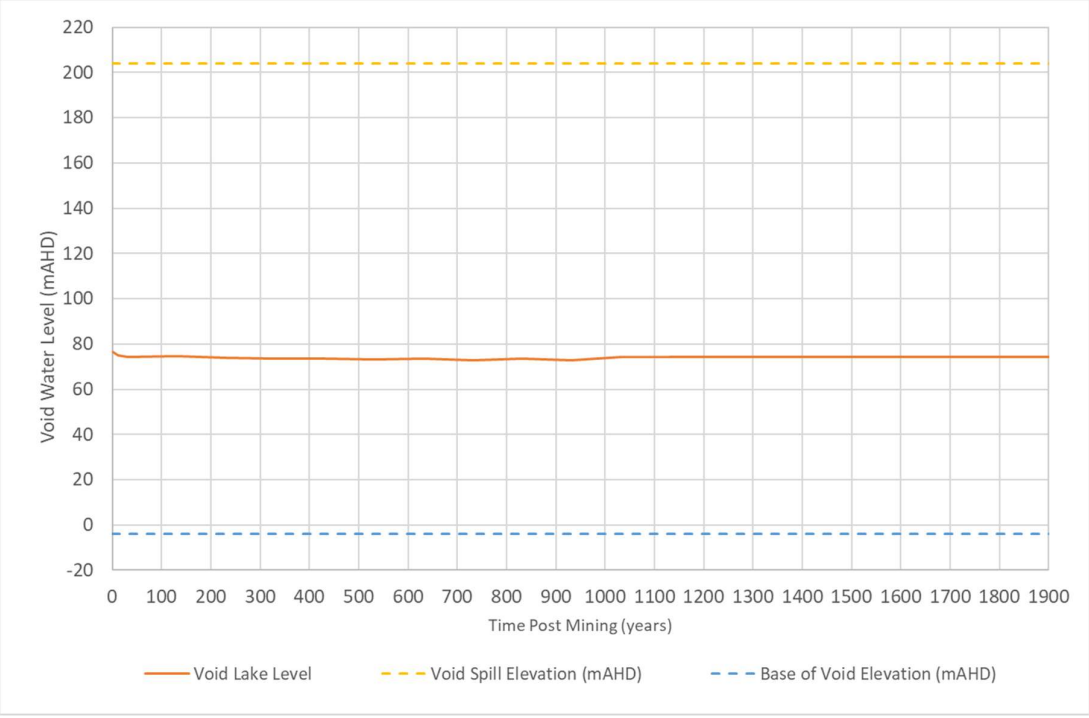


Figure 8-7 Simulated Void Water Level Recovery – Stewarton North

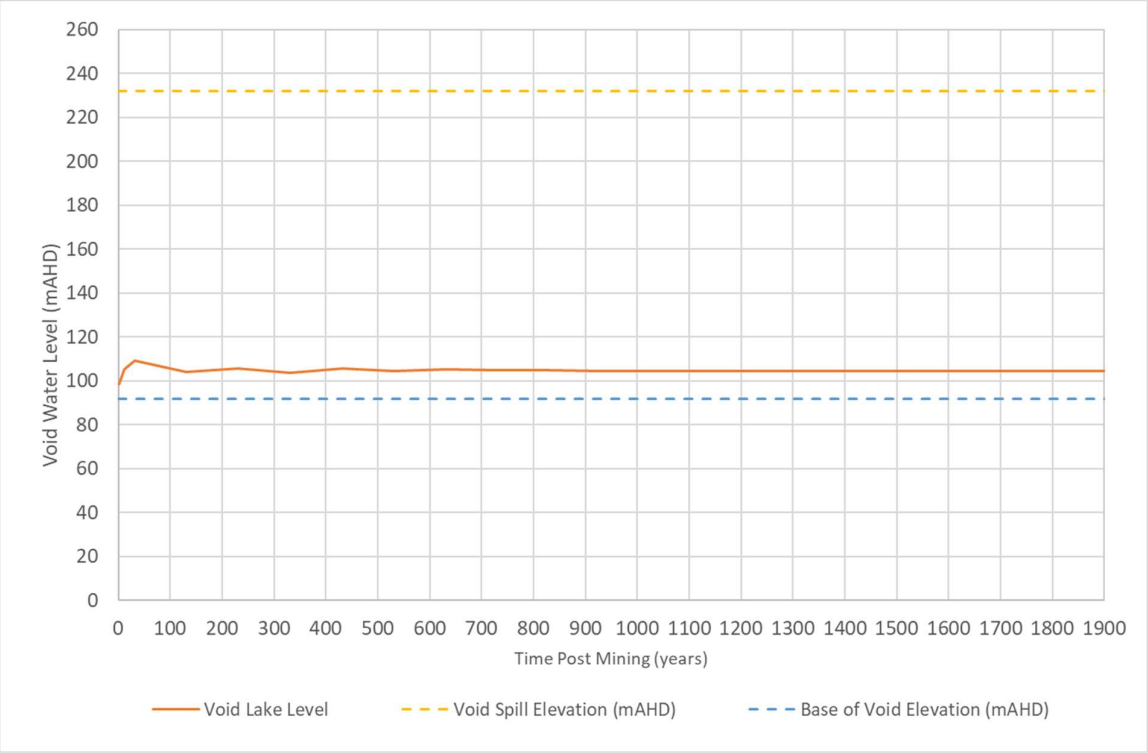


Figure 8-8 Simulated Void Water Level Recovery – Stewarton South

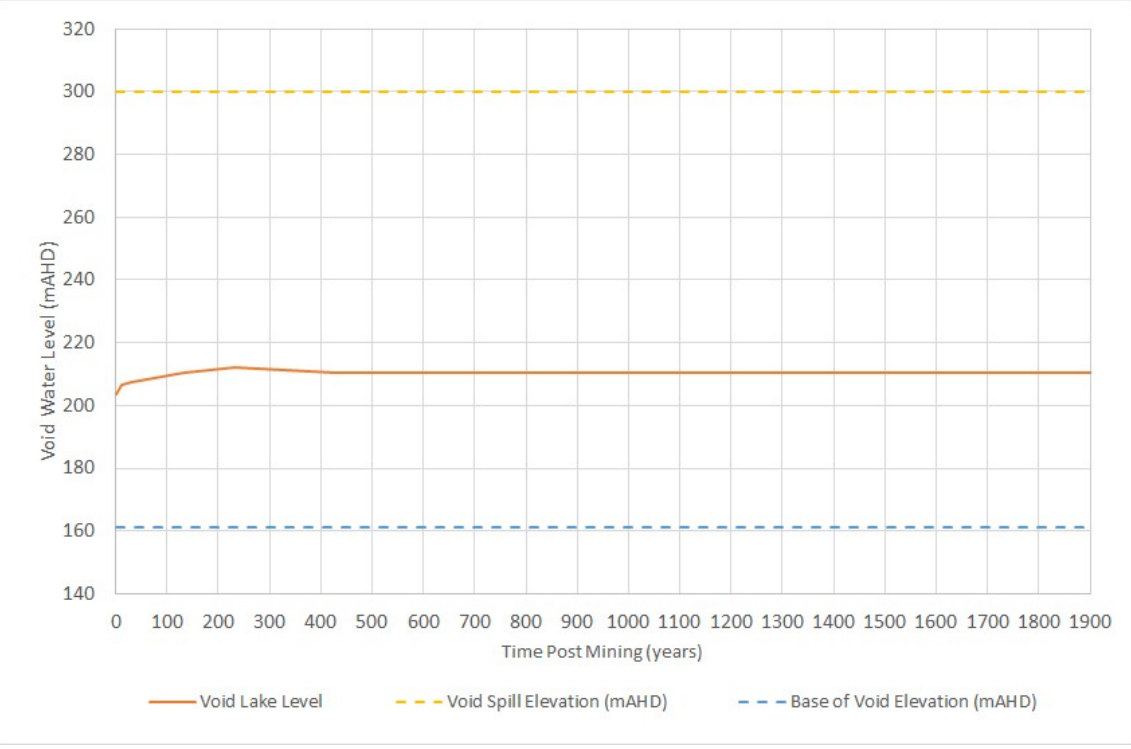


Figure 8-9 Simulated Void Water Level Recovery – Kenmare

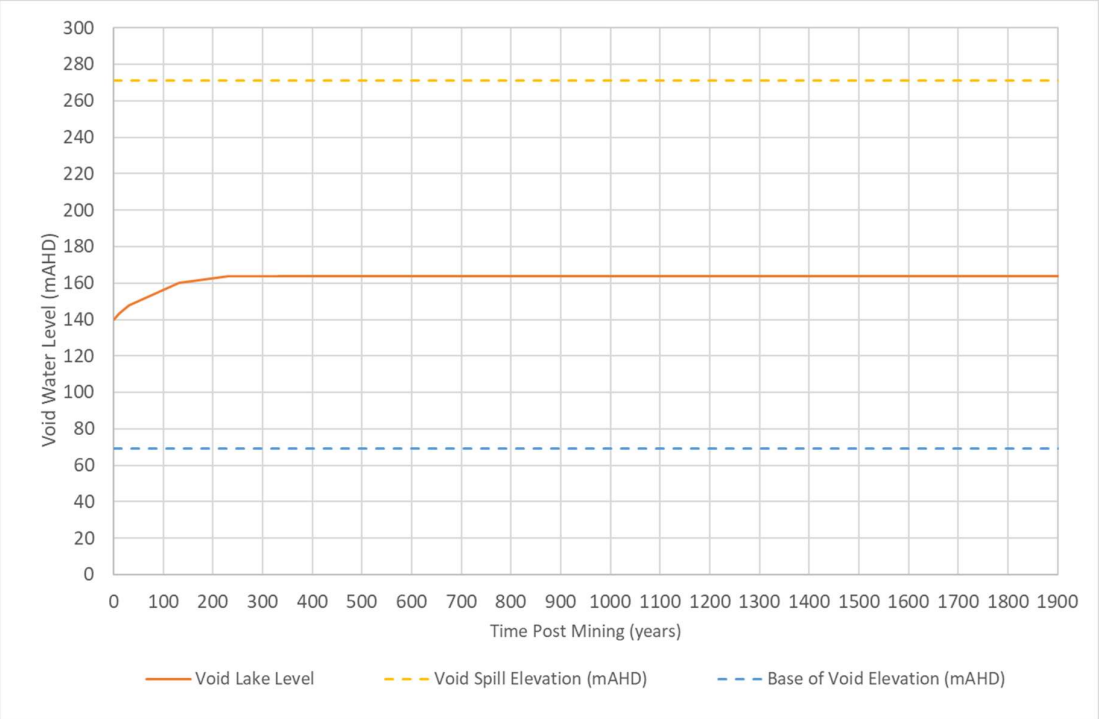


Figure 8-10 Simulated Void Water Level Recovery – Togara/North Marshmead

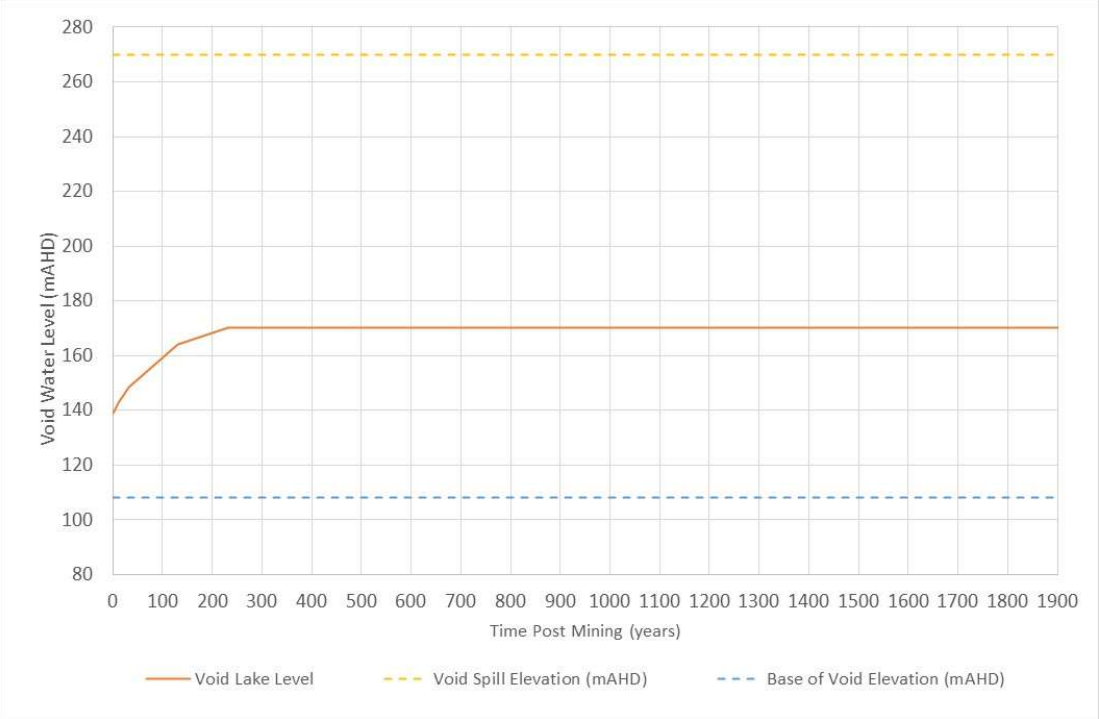


Figure 8-11 Simulated Void Water Level Recovery – South Marshmead

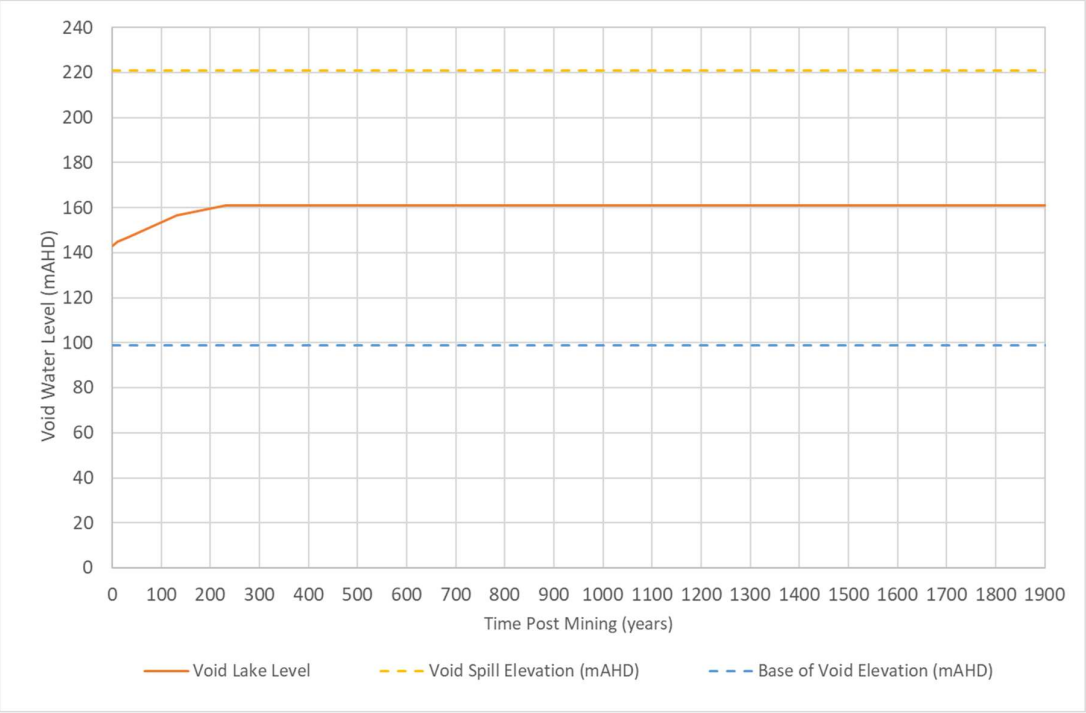


Figure 8-12 Simulated Void Water Level Recovery – Kennedy West

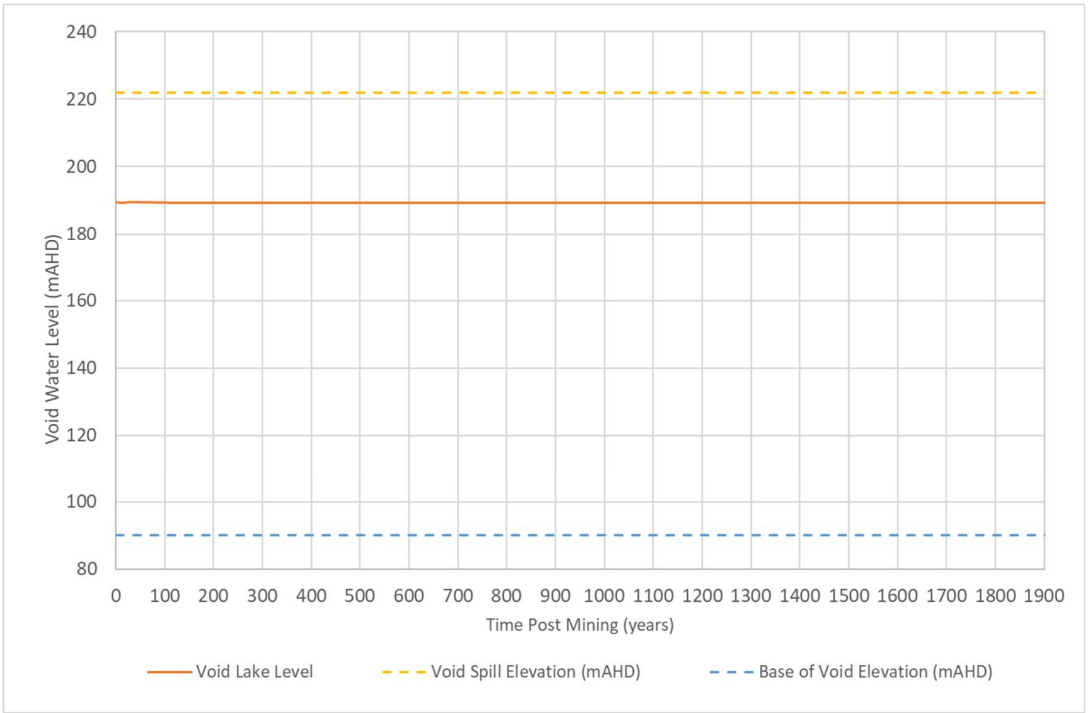


Figure 8-13 Simulated Void Water Level Recovery – Comet Downs East

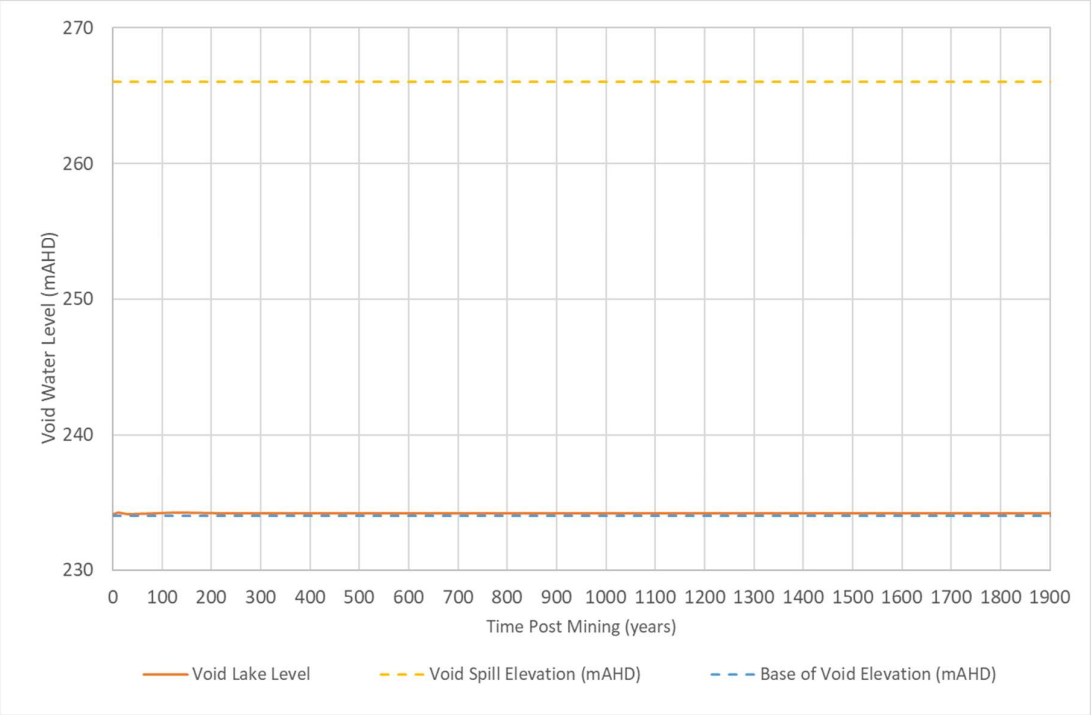


Figure 8-14 Simulated Void Water Level Recovery – R74

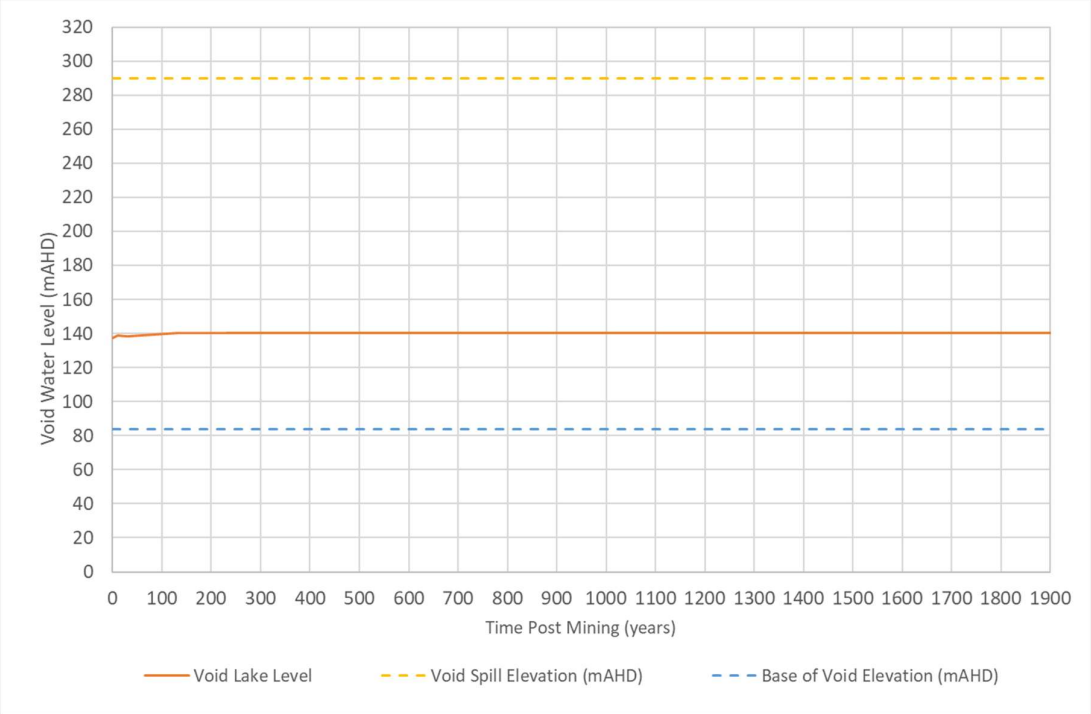


Figure 8-15 Simulated Void Water Level Recovery – South Ballamoo

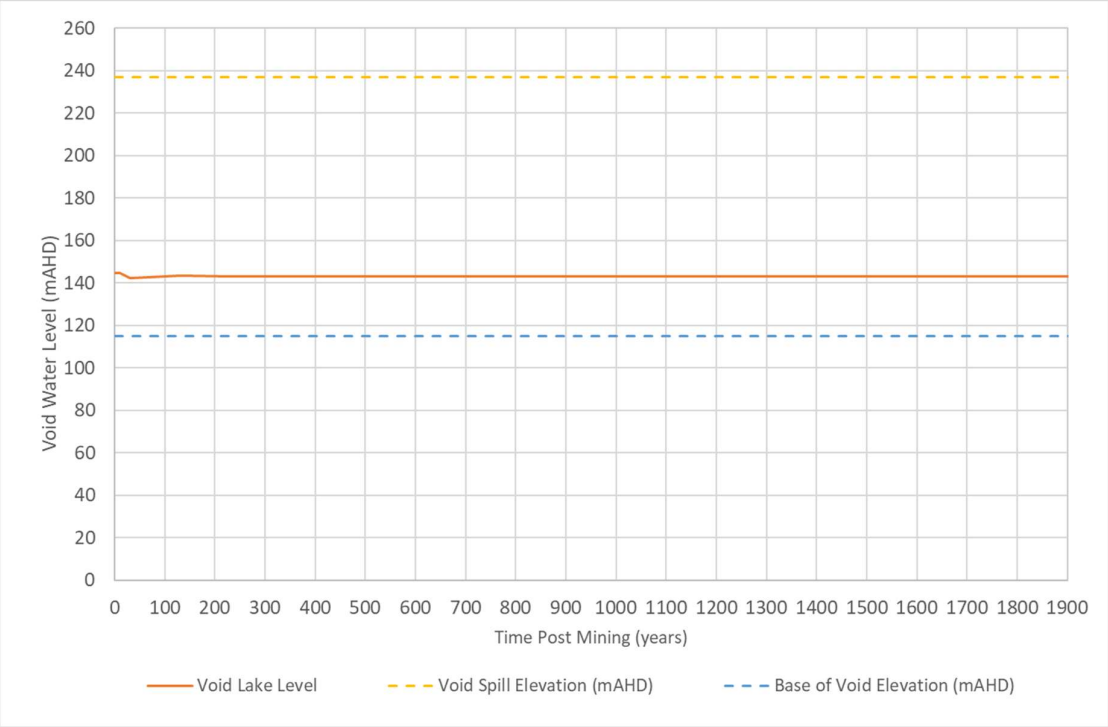


Figure 8-16 Simulated Void Water Level Recovery – Tannyfoil

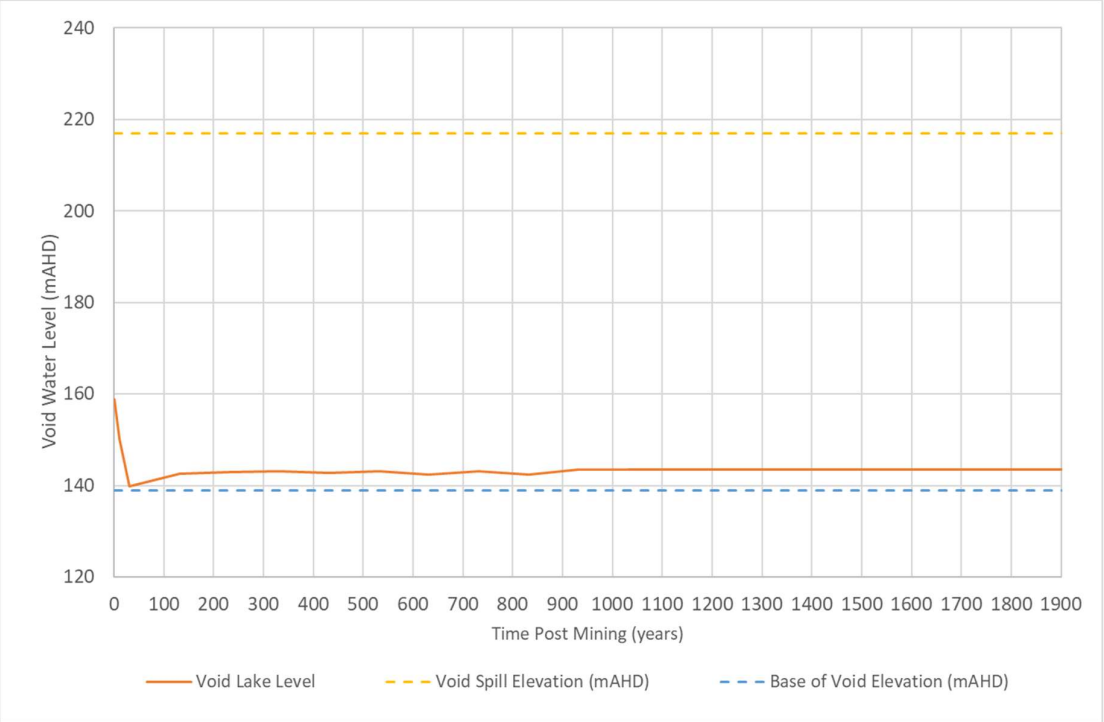


Figure 8-17 Simulated Void Water Level Recovery – R30

Figure 8-3 through **Figure 8-17** show that the residual void water level recovery is a process that takes decades to centuries, with the recovery rate generally declining as the lakes reach equilibrium conditions. For the majority of the residual voids, equilibrium water level conditions are reached after approximately 100 to 300 years. 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 spill level elevation) is shown in **Table 8-2**. Predicted void lake levels remain significantly below the surface 'spill' level for each of the residual voids.

Table 8-2 Predicted Freeboard in the Residual Voids at Equilibrium

Residual Void	Freeboard (m)
Ramp 8	30
Bonnie Doon	17
Mimosa/ Besgrove	115
Deep Creek	63
Stewarton North	130
Stewarton South	127
Kenmare	90
Togara/ North Marshmead	107
South Marshmead	100
Kennedy West	60
Comet Downs East	33
R74	32
South Ballamoo	84
Tannyfoil	94
R30	74

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 (model layers 1 and 2) adjacent the voids is as shown in **Table 8-3**. Predicted residual void lake levels remain significantly below the base of the shallow geologic formations for each of the residual voids, with the exception of Comet Downs East. Thus, for most voids, the modelling indicates that it is highly unlikely for a flux of water to leave the residual voids and enter the shallow geologic formations. For Comet Downs East the modelling predicts void lake level above the deeper weathering profile (i.e. base of regolith). This is discussed in detail in **Section 8.2.4** and **Section 8.2.6** in relation to the potential for flux of water to leave these voids via the weathering profile.

The predicted lake levels in the Kenmare residual void at equilibrium (215 mAHD) remain above the elevation of the Kenmare Underground and Laleham Underground workings that would be exposed in the void highwall (i.e. of the Pollux Seam at approximately 195 and 156 mAHD respectively). This indicates that the Kenmare Underground and Laleham Underground workings remain permanently flooded and there is no potential for oxidisation within the underground workings.



Table 8-3 Predicted Difference between Void Lake Levels and Shallow Formations

Residual Void	Lowest elevation of base of shallow unconsolidated sediments adjacent void (mAHD)	Difference between lowest elevation of base of shallow unconsolidated sediments adjacent void and void lake level (m)[1]	
		Start of Post-Mining	Post-Mining Equilibrium
Ramp 8	176	29	31
Bonnie Doon	175	12	16
Mimosa/ Besgrove	187	103	103
Deep Creek	204	55	65
Stewarton North	204	128	130
Stewarton South	204	105	99
Kenmare	269	52	54
Togara/ North Marshmead	251	111	87
South Marshmead	222	83	52
Kennedy West	187	44	26
Comet Downs East	188	-46	-1
R74	241	7	7
South Ballamoo	251	114	111
Tannyfoil	218	73	75
R30	210	63	67

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

8.2.4 Residual Void Groundwater Inflow

The predicted groundwater inflows to the residual voids from the groundwater model are shown on **Figure 8-18** through **Figure 8-32**. The inflows are partitioned between that which flows into the residual voids through spoil (primarily on the low-wall side), and that which flows into the residual voids through surrounding natural geological formations via highwalls and end walls that remain exposed to the voids.

As mining activity ends in different years for each void, the duration over which groundwater levels in spoil and natural geology adjacent to the residual voids remain suppressed after mine closure (2094) is variable.

During early model stress periods prior to equilibrium, fluxes between the voids and adjacent spoil and bedrock formations is more temporally variable than towards the end of the recovery simulation, however despite this variability most voids still behave as net groundwater sinks for both spoil and non-spoil groundwater sources. The four exceptions to this are Ramp 30, Ramp 74, Stewarton South and Bonnie Doon residual voids, that show net negative groundwater inflow (i.e. net outwards flux). These residual voids are predicted to lose void water to adjacent voids via the natural geology between them at relatively small rates of 0.2, 2.3 and 0.04 and 0.14 ML/day respectively at post-mining equilibrium. Each of these voids with a net outwards flux have predicted lake elevations that are higher than the neighbouring voids (**Section 8.2.3**), resulting in a hydraulic gradient between the voids that drives this outwards flux from each void to its neighbouring void. This negative groundwater flux thus represents movement of water between voids, not flux away from the BWM site. The fate of this localised post-closure outwards flux of void water is discussed in **Section 8.2.6**.

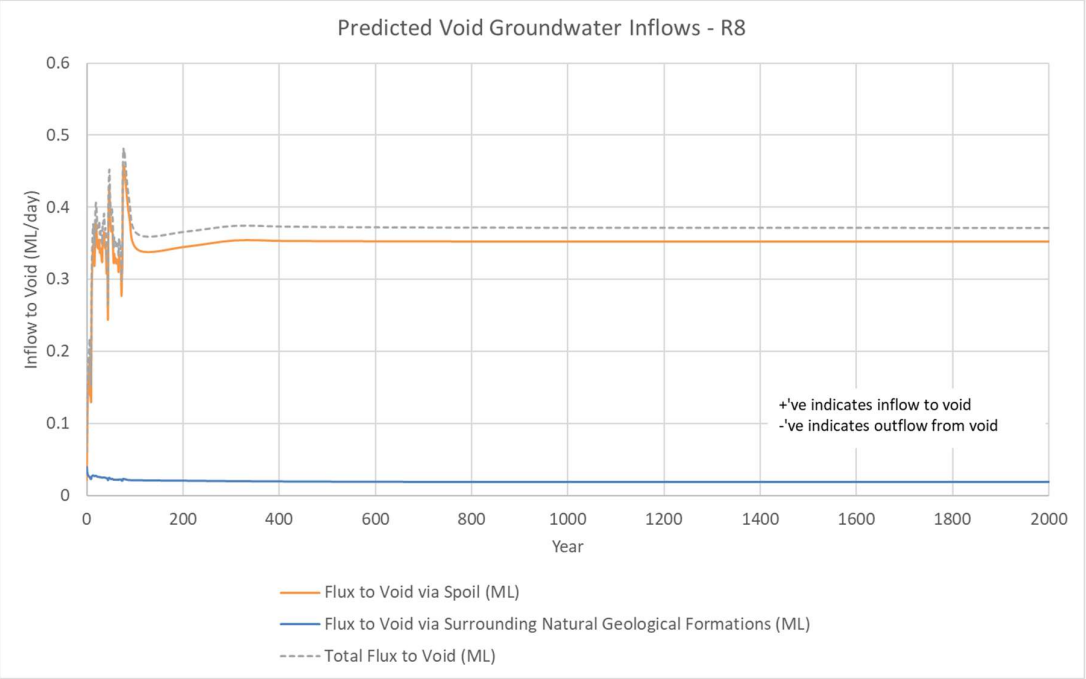


Figure 8-18 Predicted Void Groundwater Inflows – Ramp 8

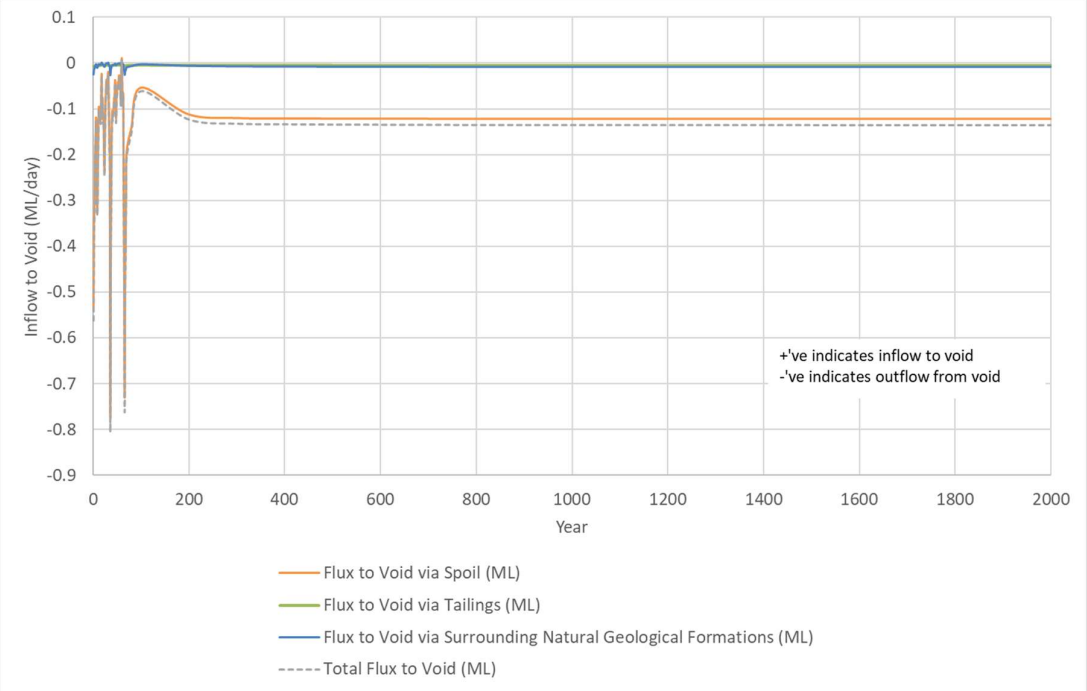


Figure 8-19 Predicted Void Groundwater Inflows – Bonnie Doon

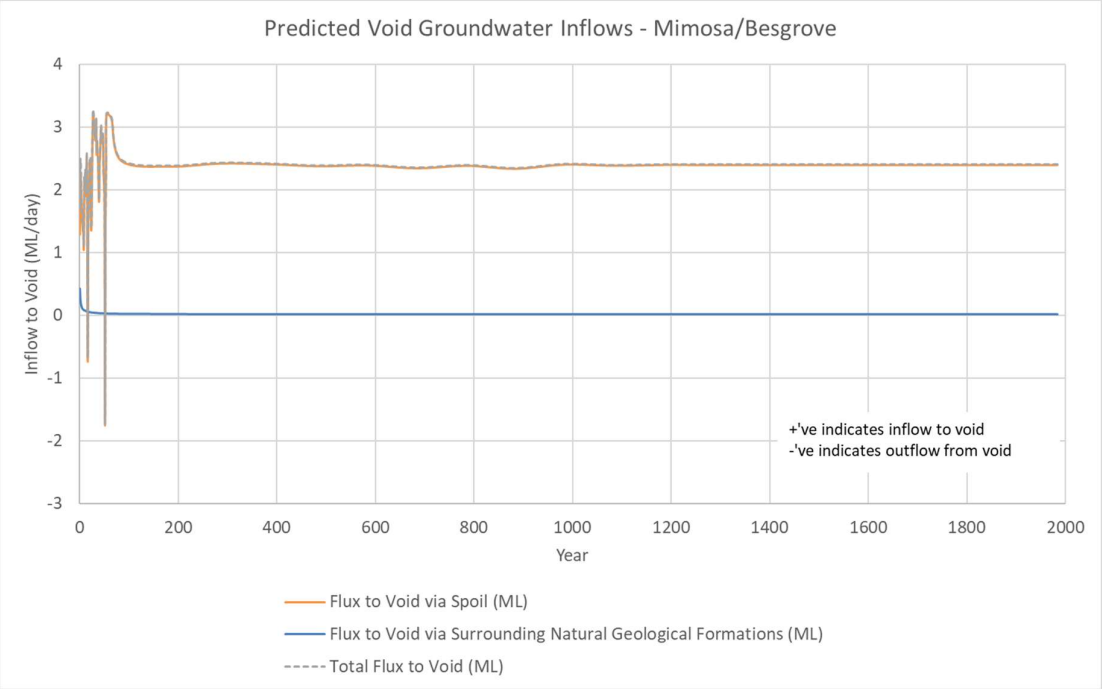


Figure 8-20 Predicted Void Groundwater Inflows – Mimosa/Besgrove

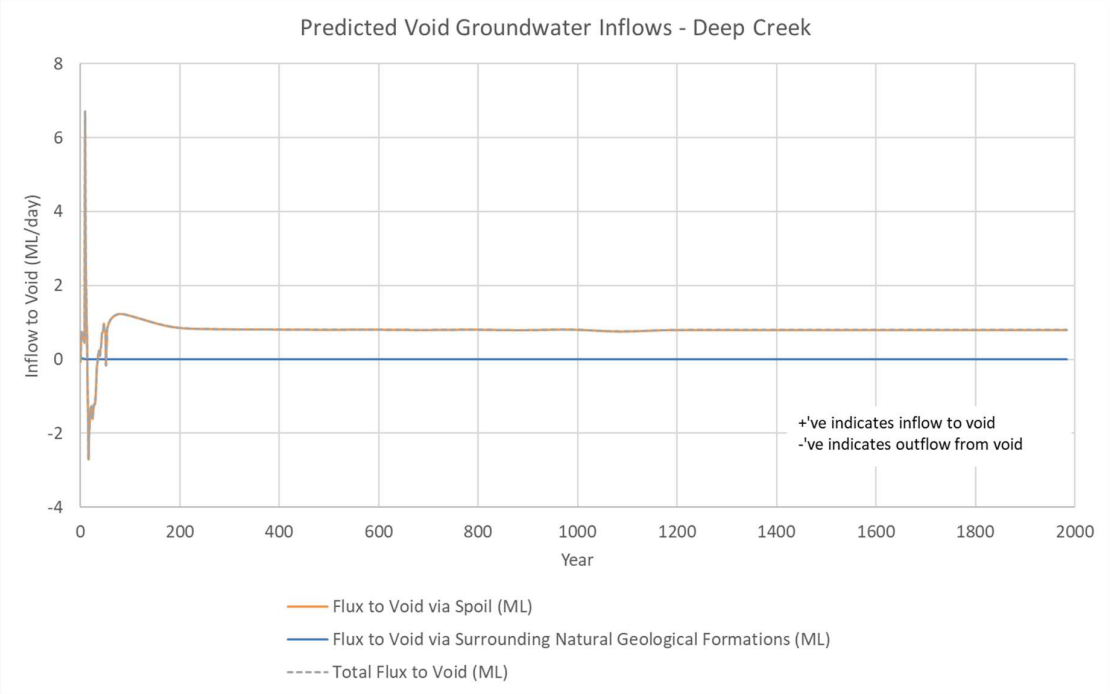


Figure 8-21 Predicted Void Groundwater Inflows – Deep Creek

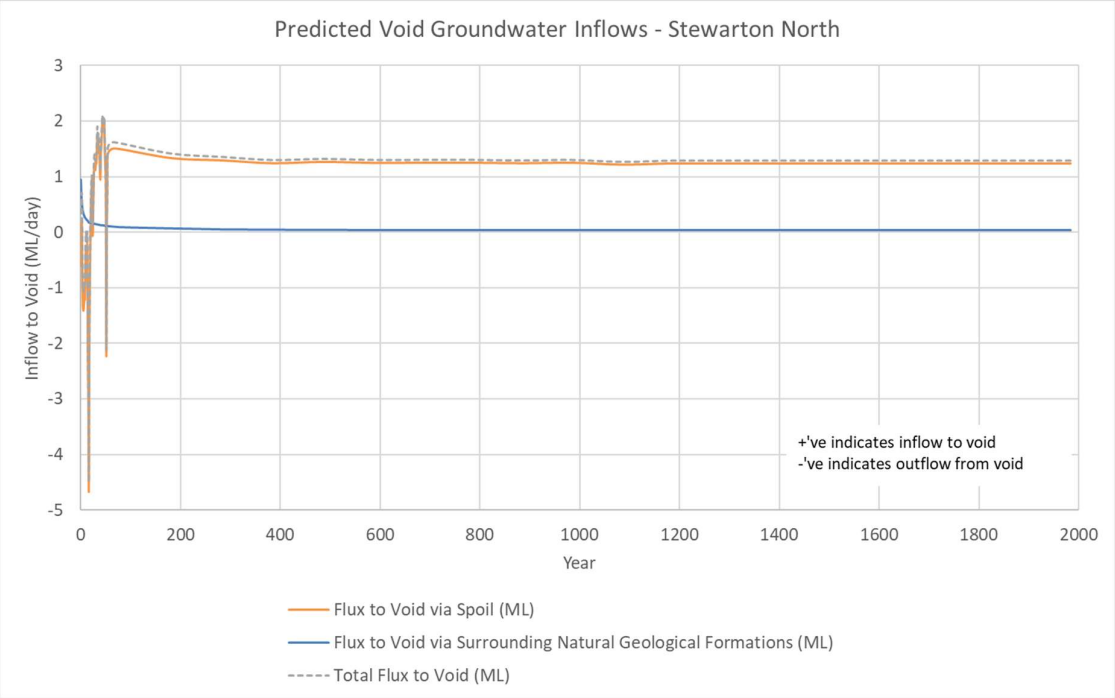


Figure 8-22 Predicted Void Groundwater Inflows – Stewarton North

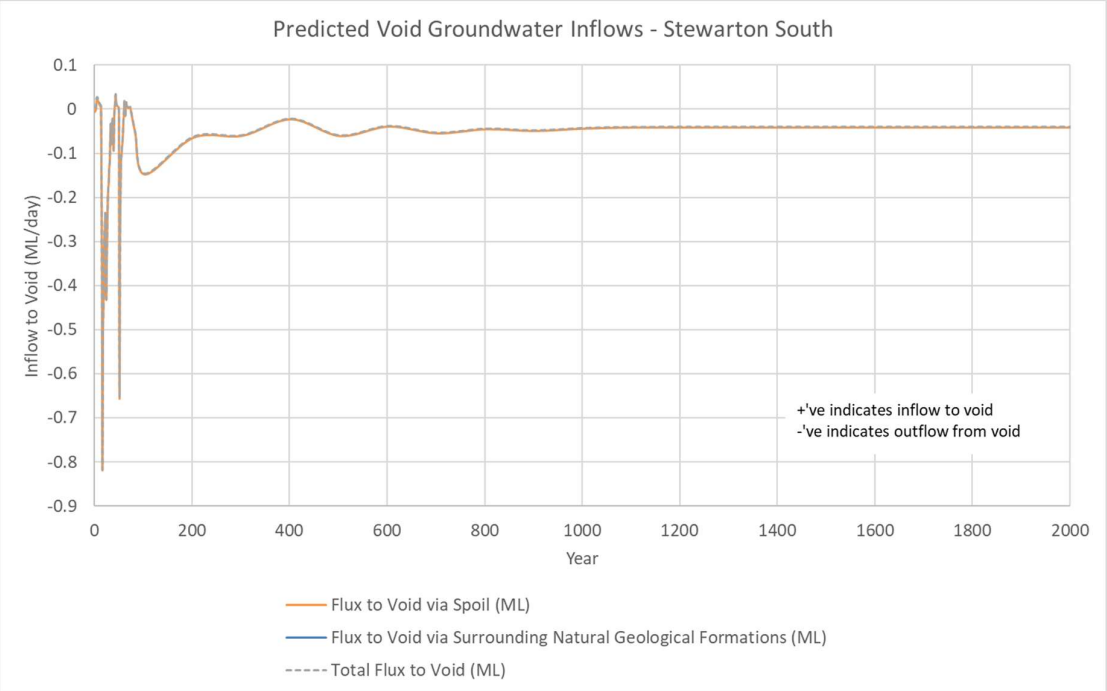


Figure 8-23 Predicted Void Groundwater Inflows – Stewarton South

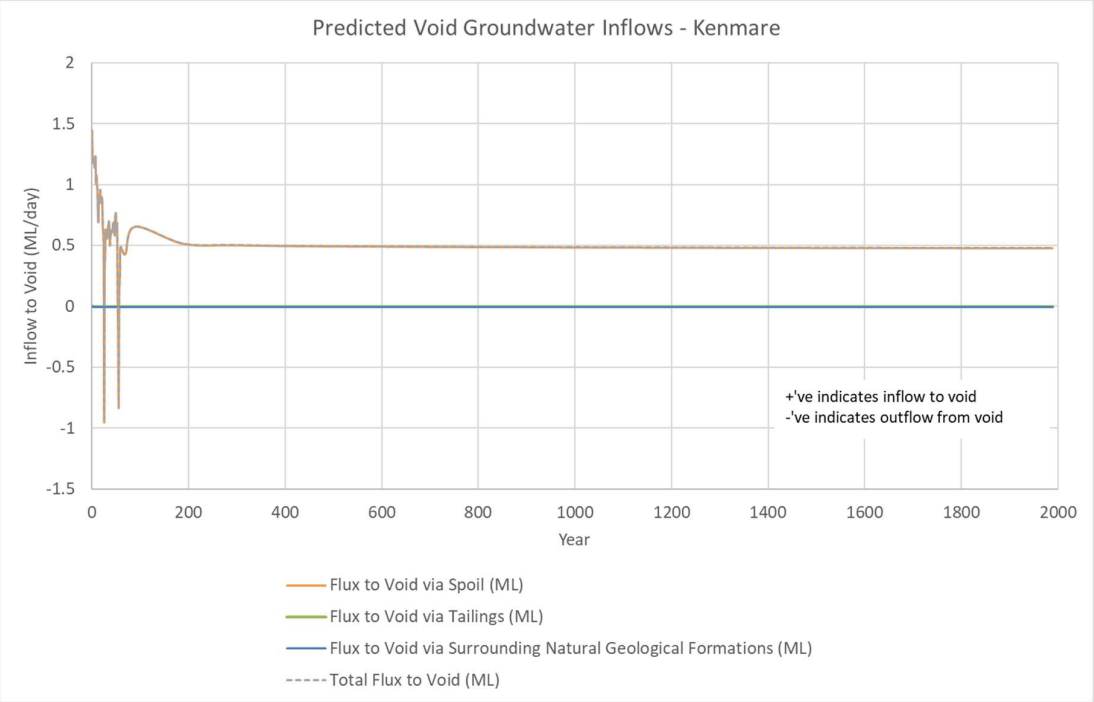


Figure 8-24 Predicted Void Groundwater Inflows – Kenmare

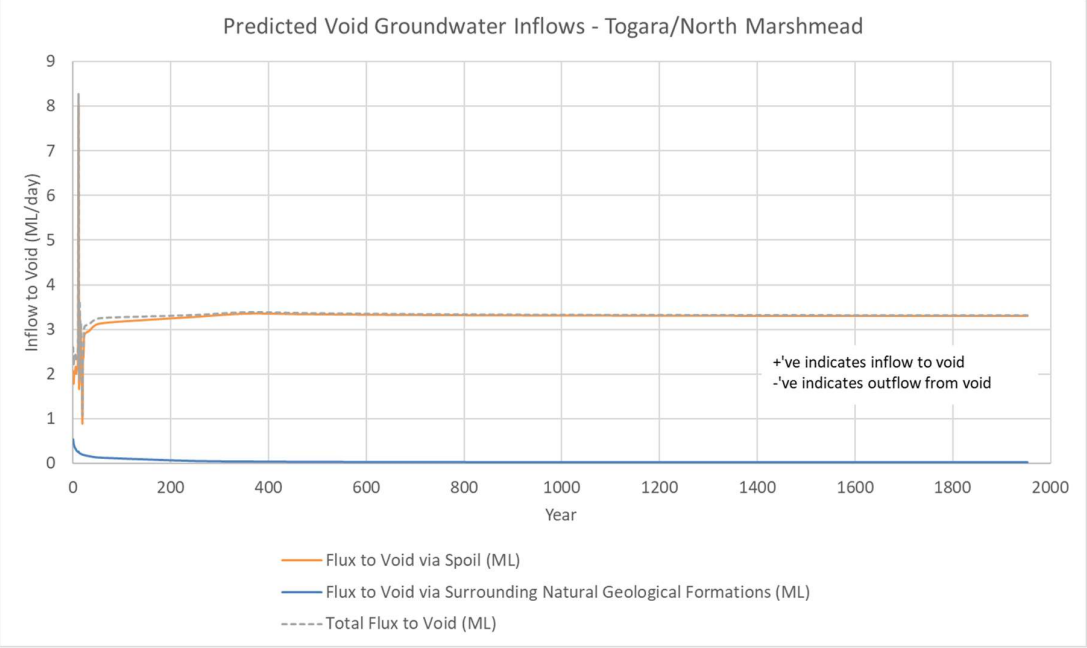


Figure 8-25 Predicted Void Groundwater Inflows – Togara / North Marshmead

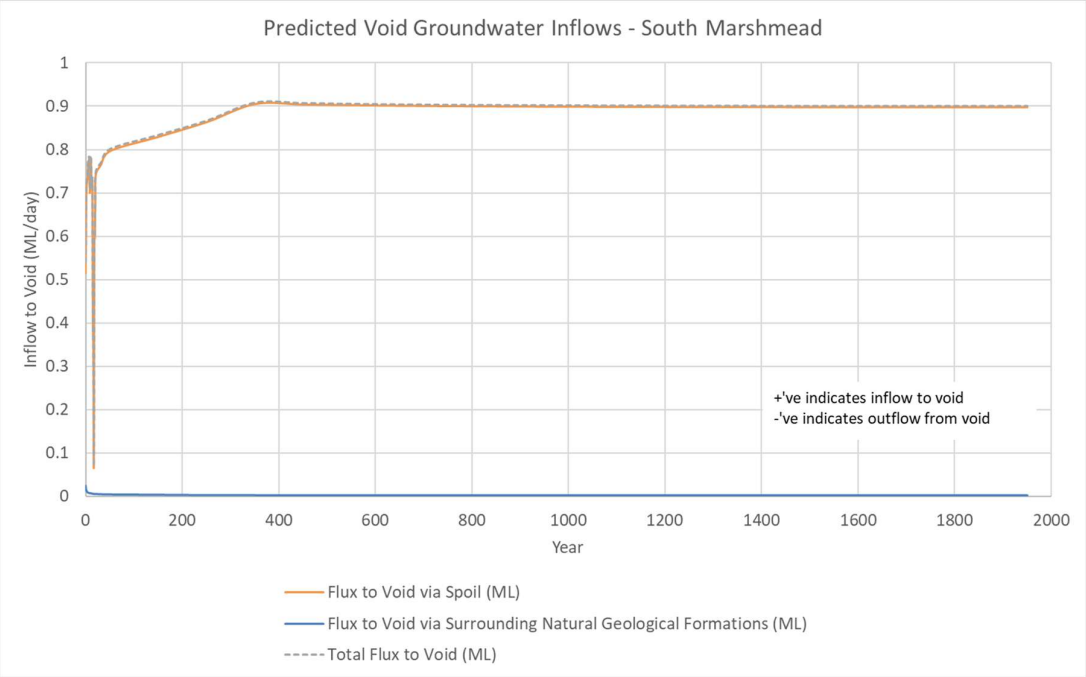


Figure 8-26 Predicted Void Groundwater Inflows – South Marshmead

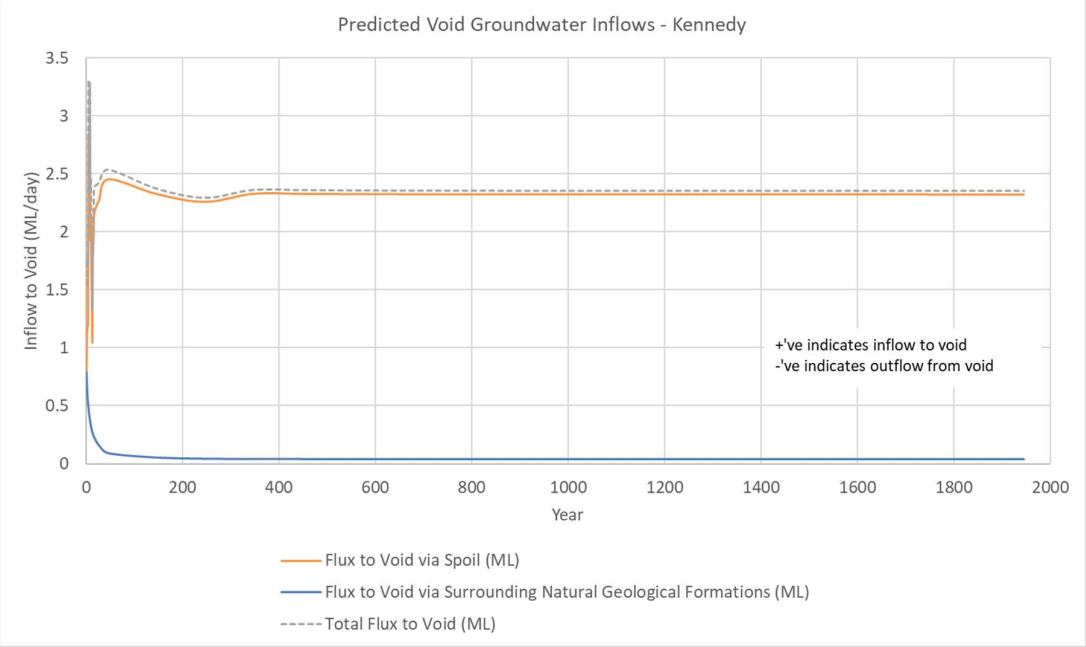


Figure 8-27 Predicted Void Groundwater Inflows – Kennedy West

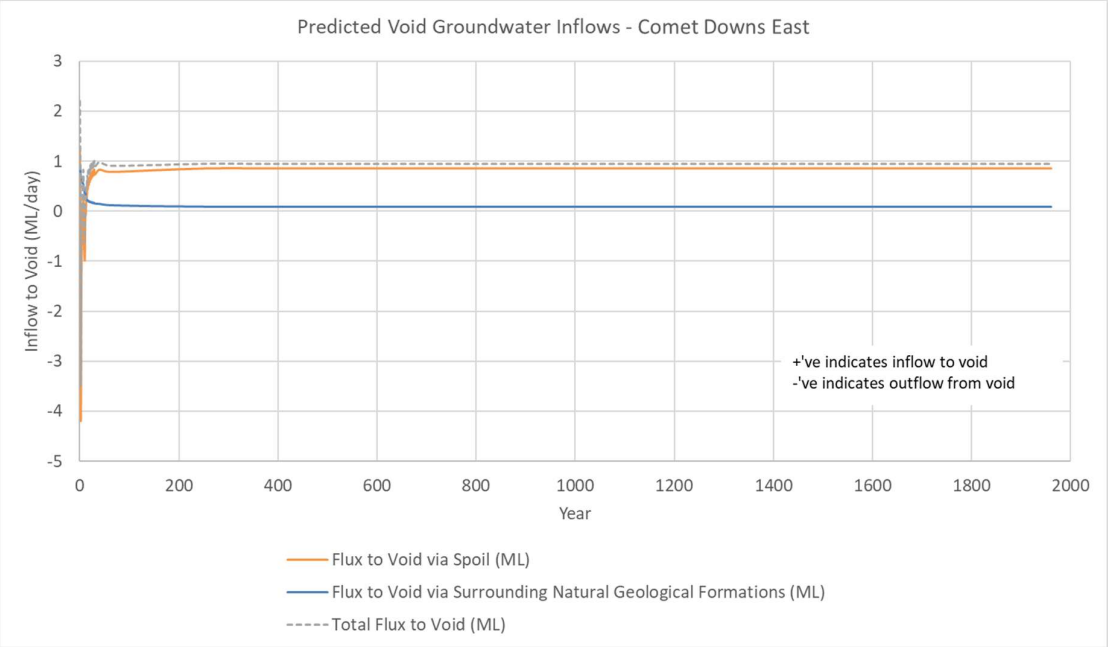


Figure 8-28 Predicted Void Groundwater Inflows – Comet Downs East

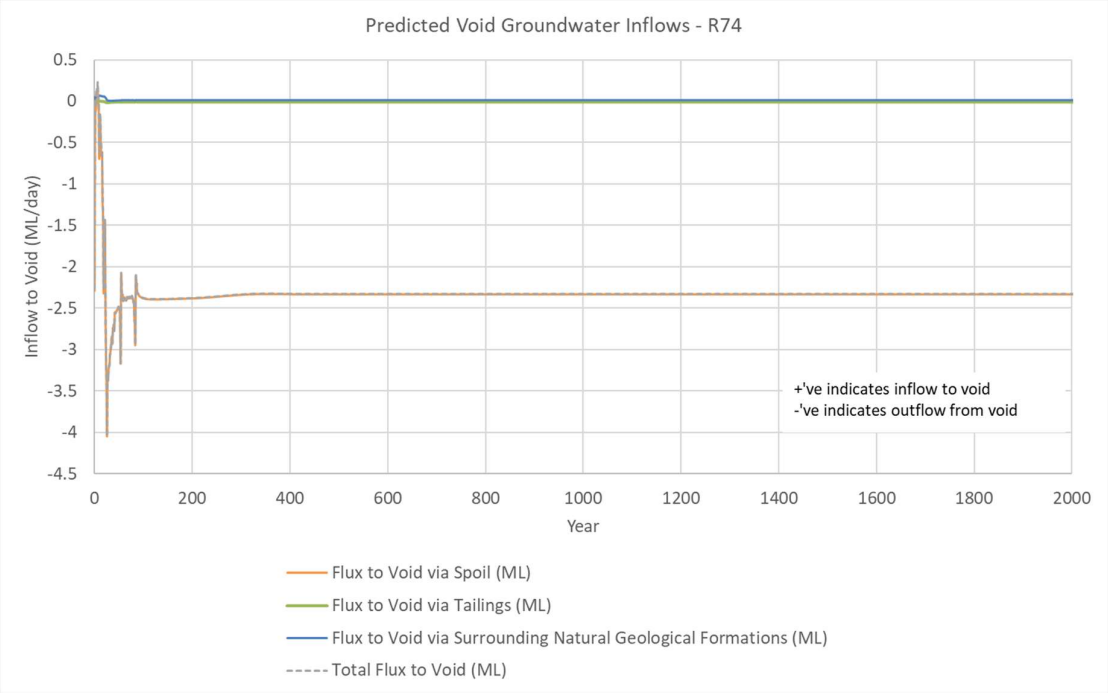


Figure 8-29 Predicted Void Groundwater Inflows – R74

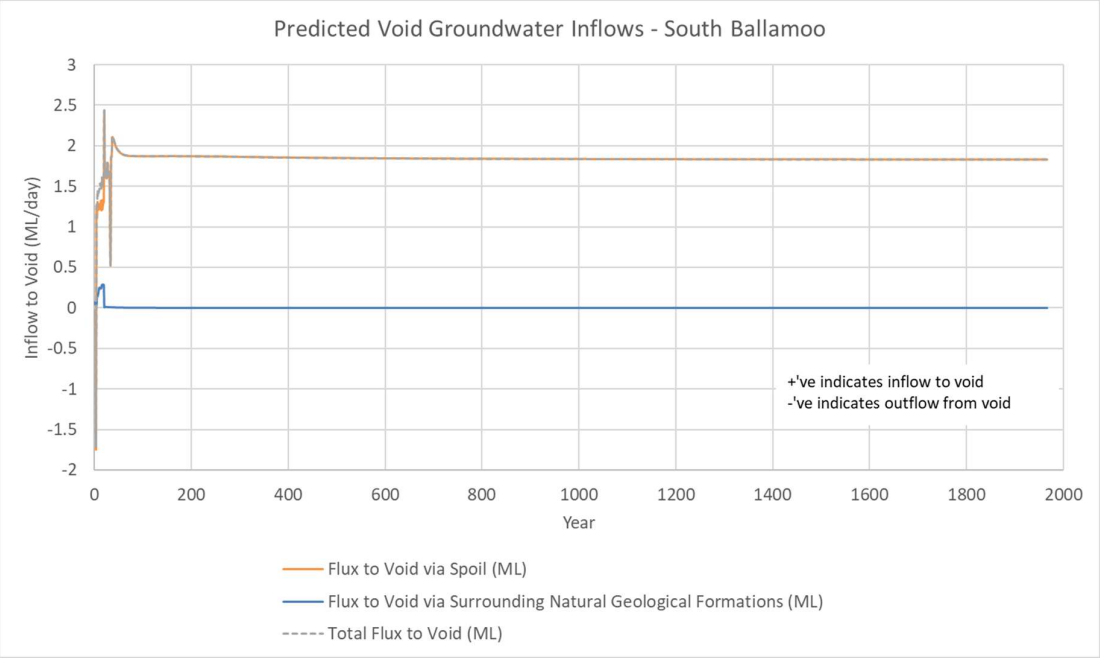


Figure 8-30 Predicted Void Groundwater Inflows – South Ballamoo

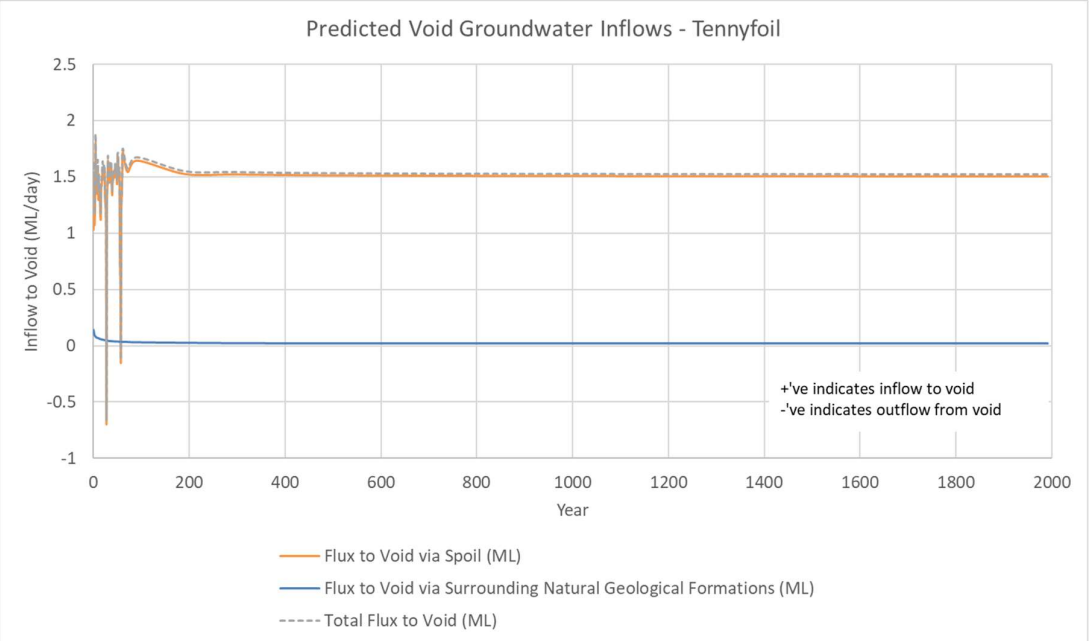


Figure 8-31 Predicted Void Groundwater Inflows – Tannyfoil

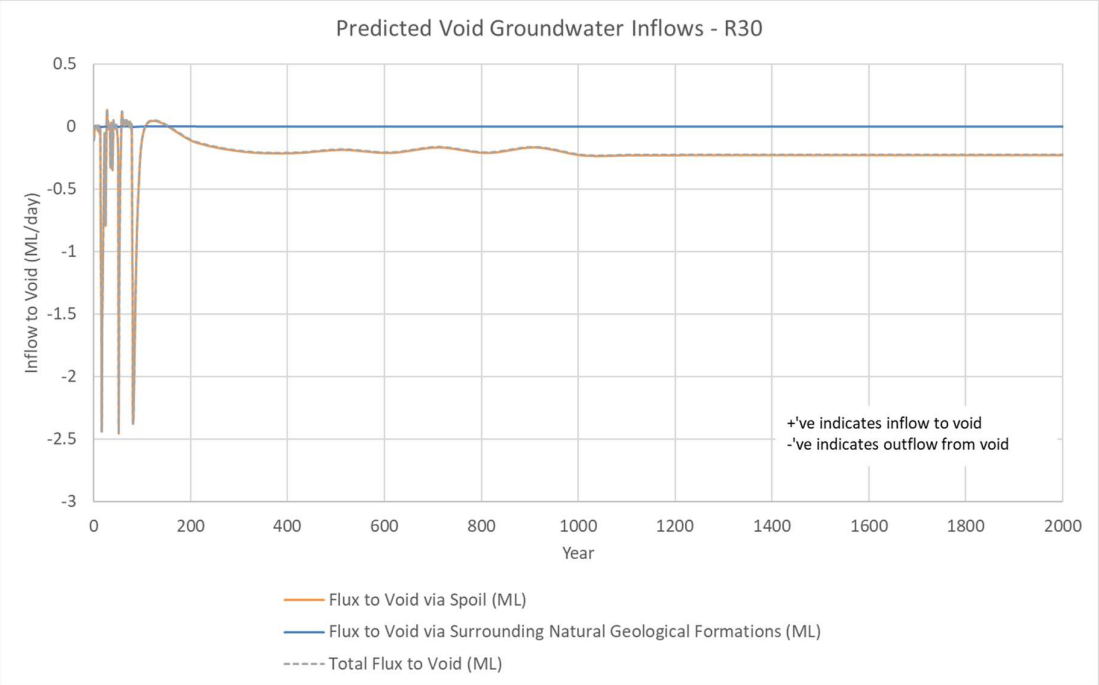


Figure 8-32 Predicted Void Groundwater Inflows – R30

Predicted equilibrium groundwater inflows to each of the residual voids are presented in **Table 8-4**. Model results indicate that across all the voids, spoil contributes between 90 % to 100% of the total net groundwater inflows to the void. The equilibrium groundwater inflows to each of the voids shown in **Table 8-4** represent a range of approximately 0 % to 70 % of the total volumetric inflow to each residual void's water balance, indicating that groundwater inflows plays an important role for some voids, but are not always the dominant driver of predicted residual void lake levels. This includes the volume of water moving between void and is not exclusively groundwater flowing towards the voids.

The equilibrium sink behaviour of the residual voids is driven by evaporative losses from the void lakes predicted by the Hydrobalance (2026) water balance model. The direct evaporation from the surface of the void lake maintains void lake levels that are lower than the surrounding groundwater levels in the long-term equilibrium state. All residual voids are predicted to behave as groundwater sinks at post-closure equilibrium with no net outflows to spoil or natural geology and the groundwater gradient remains towards the voids. As discussed previously Stewarton South, Ramp 30, Ramp 74 and Bonnie Doon residual voids have net negative fluxes via movements of water between final voids.

Stewarton South, Ramp 30, Bonnie Doon and Ramp 74 residual voids are predicted to lose void water to adjacent voids via the natural geology between the voids at relatively small rates as discussed above. Each of these voids have predicted lake elevations that are higher than the neighbouring voids (**Section 8.2.6**), resulting in a hydraulic gradient between the voids that drives this outwards flux from each void to its neighbouring void. This is the case between:

- Ramp 30 (143 mAHD) and Mimosa/Besgrove (83 mAHD);
- Bonnie Doon (159 mAHD) and Ramp 8 (145 mAHD); and
- Ramp 74 (234 mAHD) and Togara/North Marshmead (163 mAHD)
- Stewarton South (104 mAHD) and Stewarton North (74 mAHD) (**Table 8-4**).

Therefore, the outwards water flux from the four "source" voids is driven by, and would eventually be captured by, the adjacent voids with lower lake levels. The fate of this permanent post-closure outwards flux of void water is further explored in **Section 8.2.6**.

Table 8-4 Equilibrium Groundwater Inflow to the Residual Voids

Residual Void	Average Flux to Void via Spoil (ML/day)	Average Flux to Void via Tailings (ML/day)	Average Flux to Void via Surrounding Natural Geological Formations (ML/day)	Average Inflow Rate – Total (ML/day)
Bonnie Doon	-0.12	-0.01	-0.01	-0.14
R74	-2.33	-0.01	0.01	-2.32
Comet Downs East	0.85	0.00	0.10	0.94
Kennedy	2.31	0.00	0.04	2.36
South Marshmead	0.89	0.00	0.00	0.89
Togara/North Marshmead	3.29	0.00	0.03	3.33
Kenmare	0.49	0.00	0.00	0.50
South Ballamoo	1.83	0.00	0.00	1.83
Tannyfoil	1.51	0.00	0.02	1.52
Stewarton South	-0.05	0.00	0.00	-0.05
Stewarton North	1.23	0.00	0.05	1.28
Deep Creek	0.79	0.00	0.00	0.79
R30	-0.21	0.00	0.00	-0.21
Mimosa/Besgrove	2.38	0.00	0.02	2.40
Ramp 8	0.35	0	0.02	0.37

8.2.5 Predicted Groundwater Levels

8.2.5.1 Potentiometric Surface Mapping

The predicted equilibrium water table elevation adjacent the residual voids is shown on **Figure 8-33**. Predicted groundwater levels for the main groundwater bearing units surrounding the final landform – the Aries, Castor and Pollux Seams of the Rangal Coal Measures (model layers 8, 10 and 12) and the Burngrove Formation (model layer 14) - are shown on **Figure 8-34** to **Figure 8-37**.

Groundwater levels surrounding the residual voids are controlled by the predicted residual void lake levels, which in turn are controlled by the rate of evaporation from the void lakes balancing surface inflows and groundwater inflows to the lakes, including a component of groundwater that moves out of the natural geological formations into the residual voids via the spoil (refer **Table 8-4**). The conceptual relationship between these components is displayed in **Figure 8-2**. That is, predicted groundwater levels surrounding the residual voids



are a function of predicted lake levels, which as discussed in **Section 8.2.3**, are mostly dominantly controlled by surface water fluxes and maintained by evaporation.

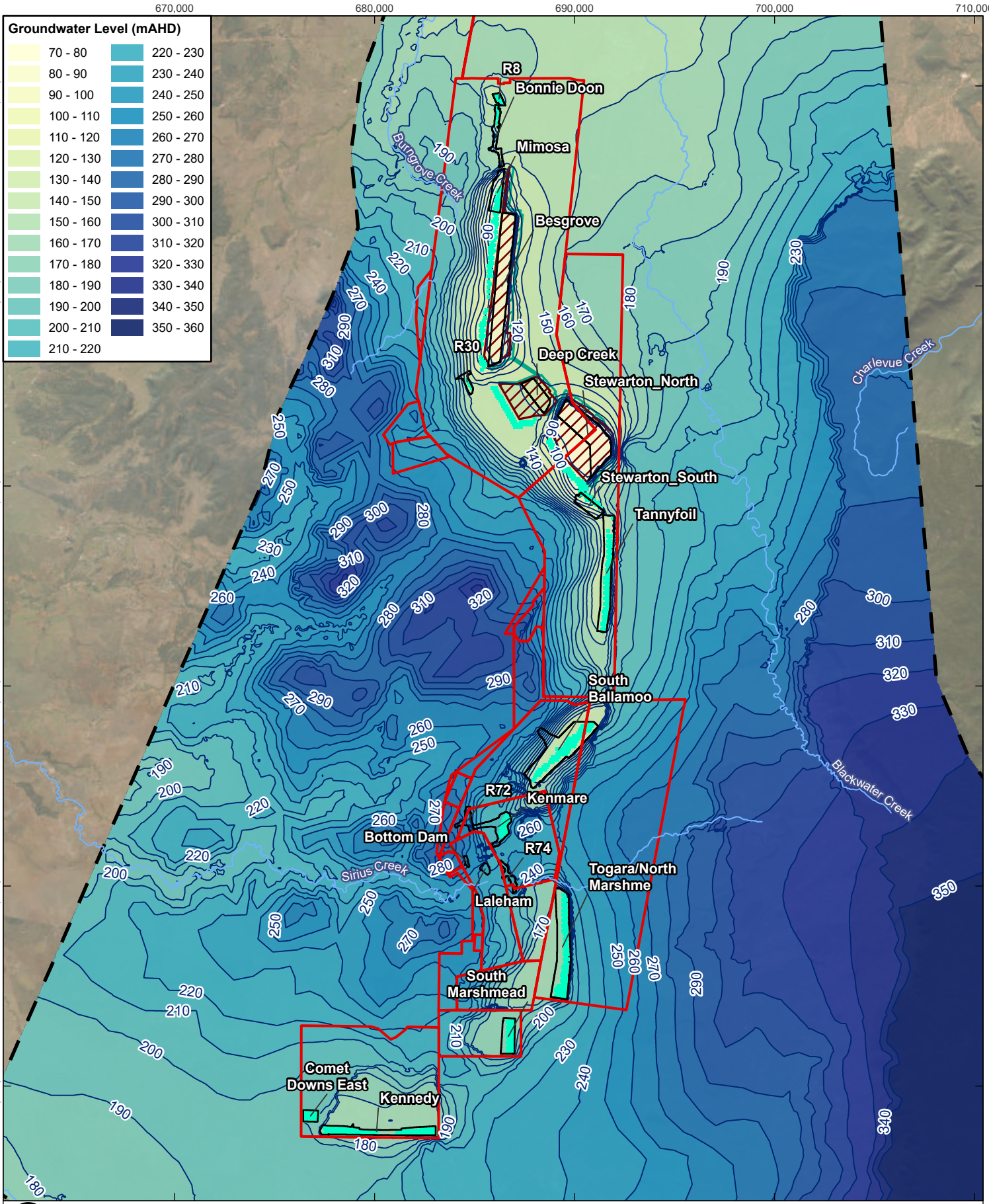
The predicted equilibrium water table elevation adjacent the residual voids is shown on **Figure 8-33**. The water table is predicted to remain depressed in the immediate vicinity of the residual voids in the long term, driven by the ongoing groundwater discharge to the residual void lakes and governed by the lake elevations themselves (**Figure 8-33**). That is, long term inwards groundwater flow gradients are maintained post-mining for the water table. Gradients in the natural rock away from the mining area and away from the residual voids are significantly smaller outside the BWM Area (with the exception of the steeper gradient observed distant to the east that occurs due to the Clematis Group escarpment). Relatively steep water table gradients also occur within the spoil emplacements to the west of the Mimosa/Besgrove, Stewarton North, Stewarton South, Tannyfoil, South Ballamoo, Kenmare, and Ramp 74 residual voids.

Predicted groundwater levels for the Aries, Castor and Pollux Seams of the Rangal Coal Measures (model layers 8, 10 and 12) and for the Burngrove Formation (model layer 16) are shown on **Figure 8-34** to **Figure 8-37**. Predicted groundwater levels for the Aries, Castor and Pollux Seams of the Rangal Coal Measures and for the Burngrove Formation indicate again that groundwater levels in the Permian sequence are 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.

The following summarises the model predicted stabilised groundwater levels as shown in **Figure 8-34** to **Figure 8-36** for the Aries, Castor and Pollux Seams:

- The Aries Seam is predicted to remain ‘dry’ in the long term across most of the mined area, with some saturation present predominantly along the east of the residual void areas. Additionally, dominant flow gradients towards the residual voids are apparent within the Aries Seam along the east of the BWM Area (**Figure 8-34**).
- The Castor Seam is predicted to remain saturated along most of the eastern margin of the mined area and within the south near the South Marshmead, Kennedy and Comet Downs East residual void areas. Dominant flow gradients in the Castor Seam are again apparent towards all the residual voids within the Aries Seam along the east of the BWM Area and surrounding Comet Downs East residual void (**Figure 8-35**).
- Predicted Pollux Seam groundwater levels show steeper gradients surrounding the southern and western side of the Besgrove, Stewarton North, South Ballamoo, R74, and Deep Creek residual voids, whilst the Togara/North Marshmead, Kenmare, Tannyfoil, and Stewarton South residual voids show steepest gradients along the western side of the residual voids. Gradients in the Pollux Seam are relatively flatter surrounding the Bonnie Doon residual void, to the east of Mimosa Besgrove, Deep Creek and Tannyfoil Residual voids and surrounding the South Marshmead, R74, Comet Downs East, and Kennedy residual voids (**Figure 8-36**).

Some saturation is predicted west of the residual voids in the model layers that formerly represented the coal seams (model layers 8, 10 and 12) but now represents emplaced spoil within former mining pits.



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	21-May-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Level (mAHD)
- BWM Mining Lease
- GIA Study Area
- Void Extent
- Void Lake
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

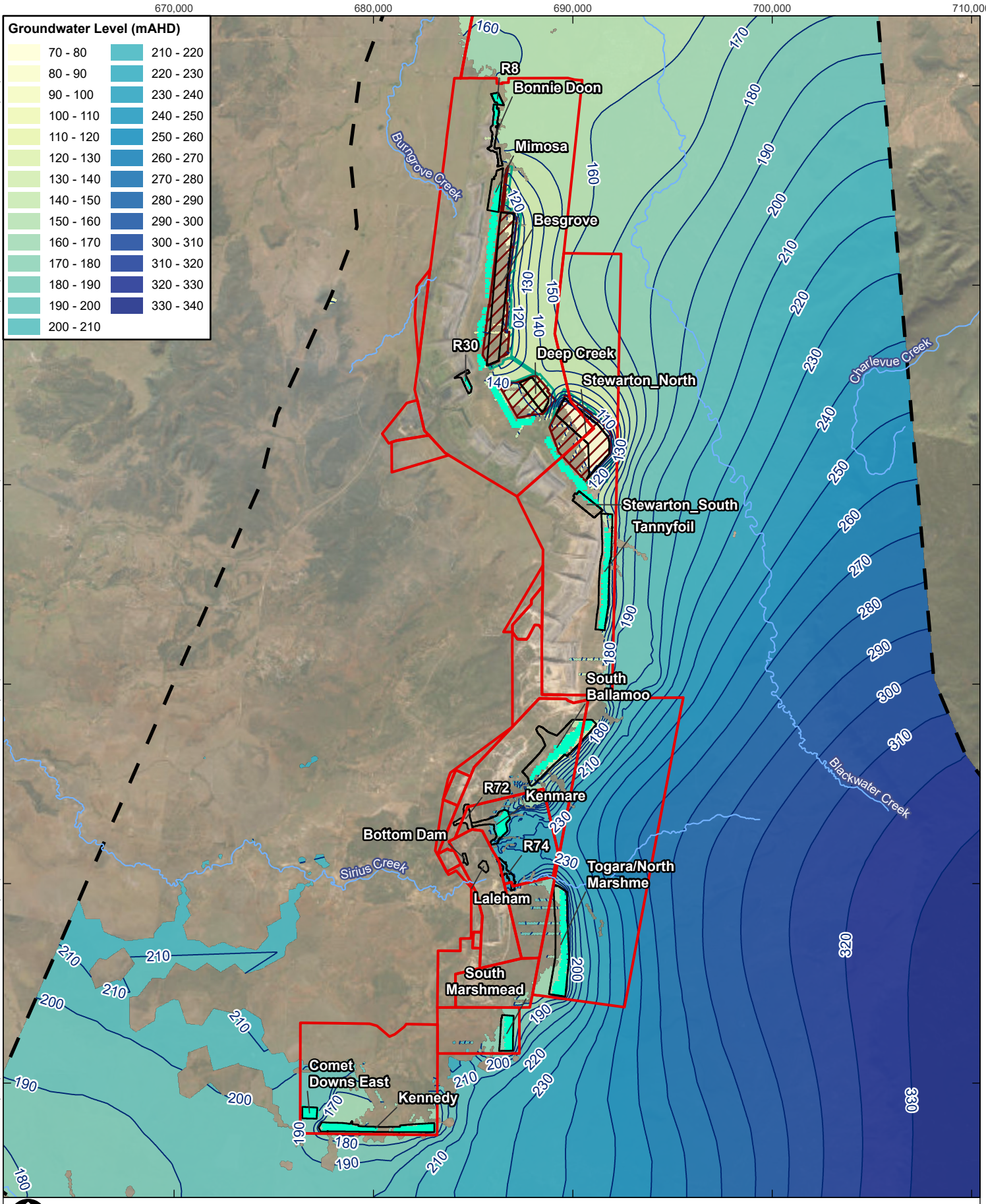
PREDICTED WATER TABLE ELEVATION – POST-MINING EQUILIBRIUM

SLR

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FIGURE 8-33

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F08_31_Predicted Water Table Elevation – PME



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	21-May-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Level (mAHD)
- BWM Mining Lease
- GIA Study Area
- Void Extent
- Void Lake
- Proposed Infrastructure Area
- Proposed Open Cut Extension

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

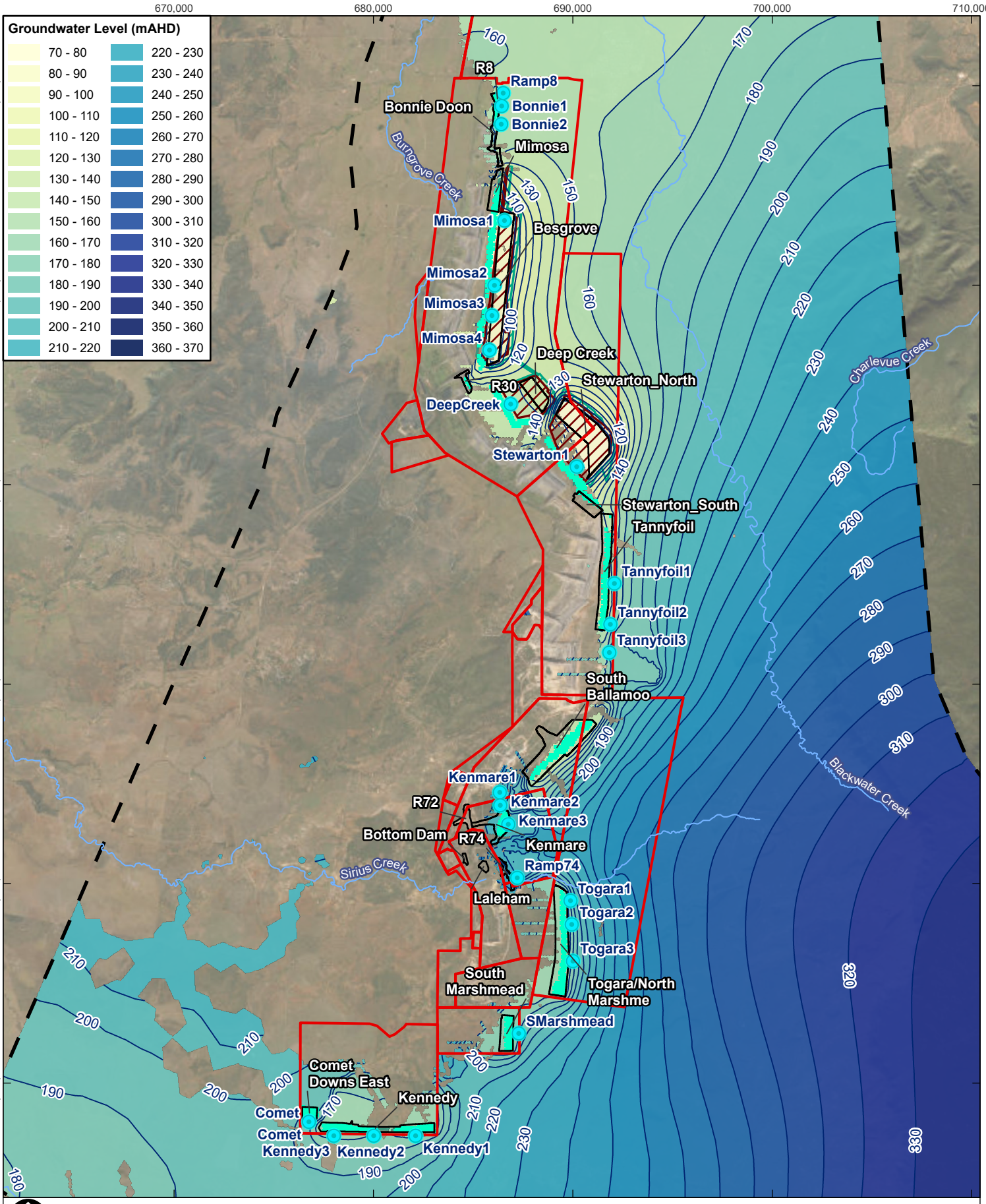
PREDICTED GROUNDWATER LEVELS IN THE ARIES SEAM (LAYER 8) – POST-MINING EQUILIBRIUM

SLR

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FIGURE 8-34

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F08_32_Predicted Groundwater Levels in the Aries Seam (Layer 8) – PME



Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	21-May-2026
Drawn by:	AS

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

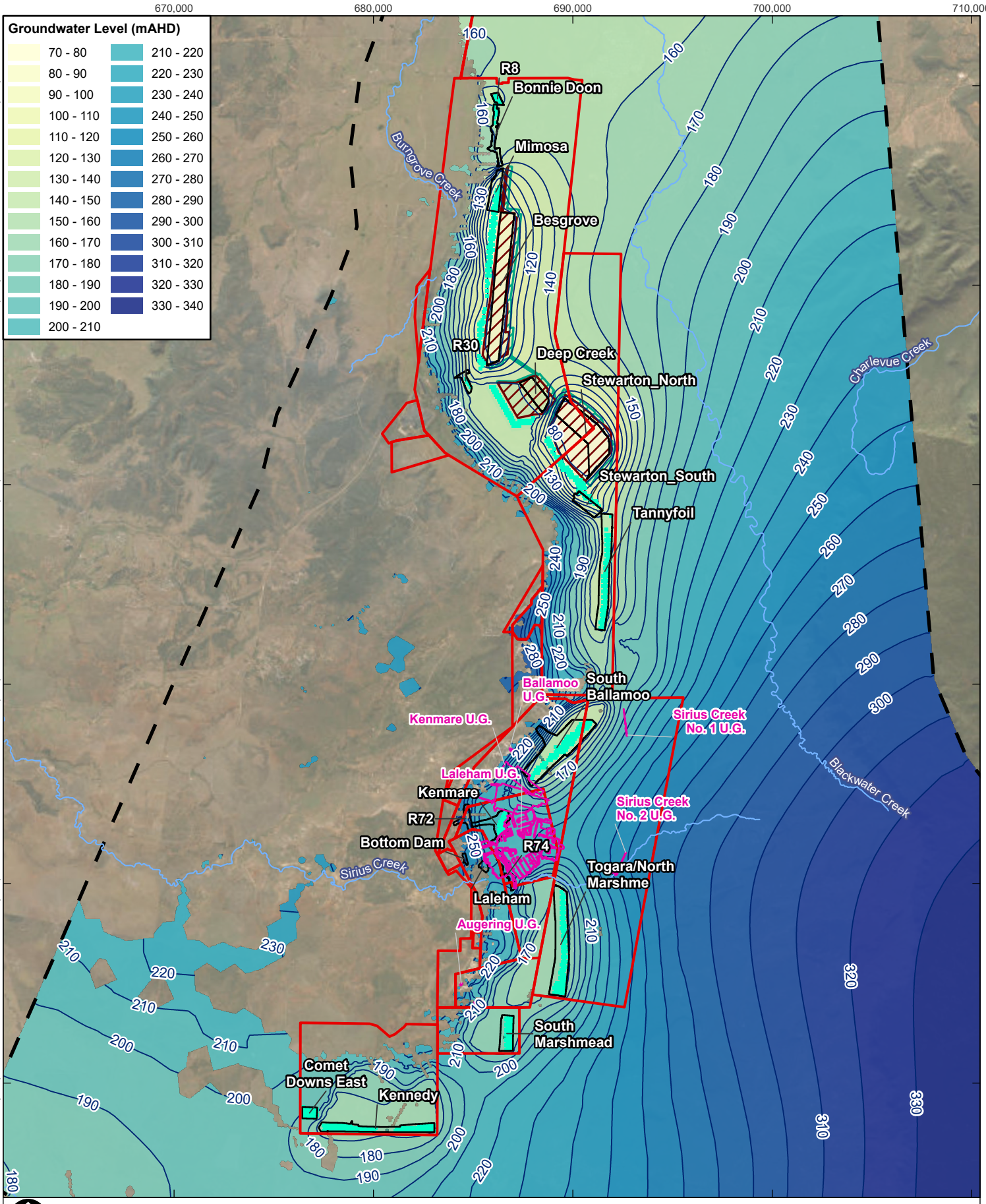
PREDICTED GROUNDWATER LEVELS IN THE CASTOR SEAM (LAYER 10) – POST-MINING EQUILIBRIUM

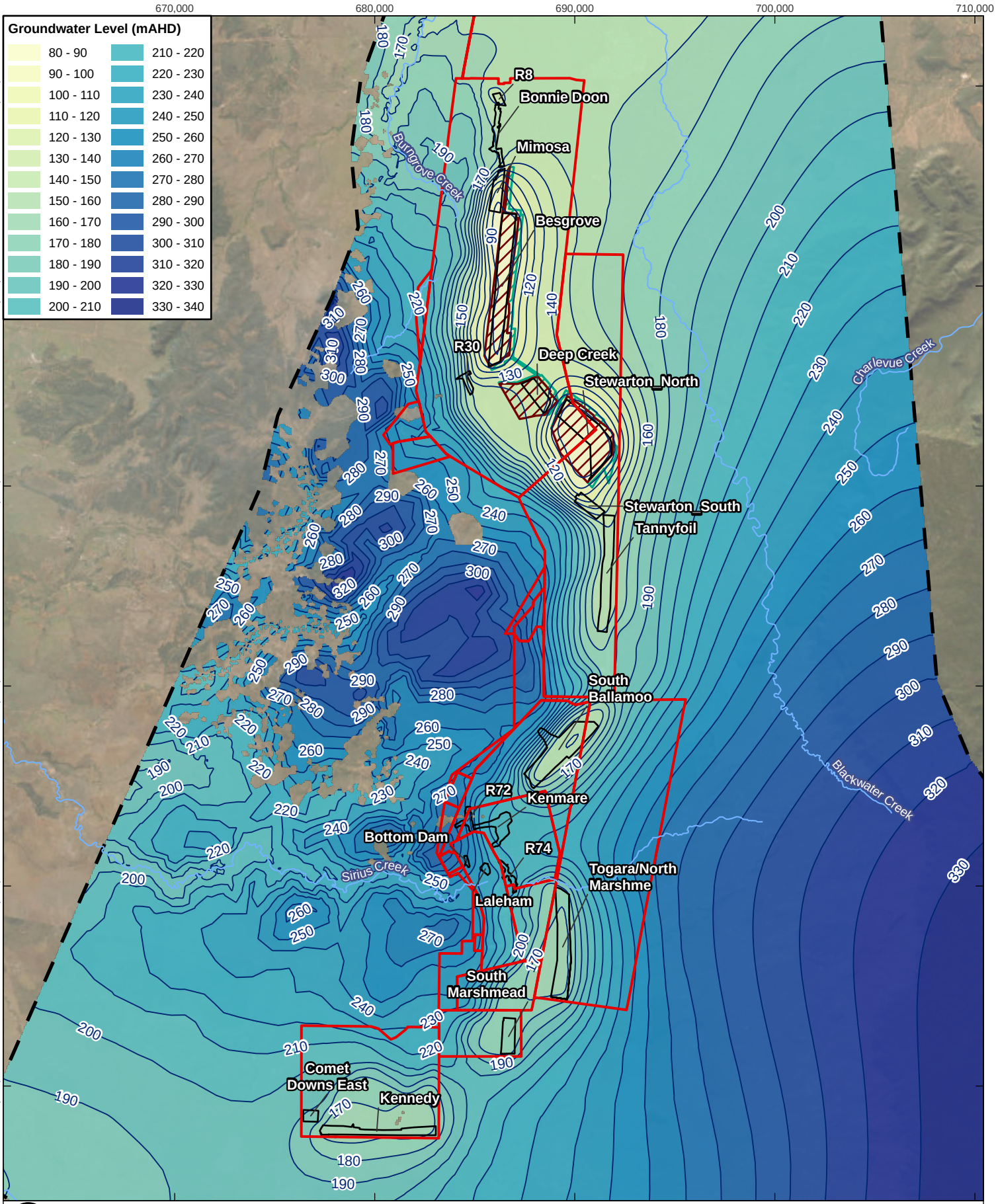
SLR

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FIGURE 8-35

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F08_33_Predicted Groundwater Levels in the Castor Seam (Layer 10) – PME


Groundwater Level (mAHD)
70 - 80
80 - 90
90 - 100
100 - 110
110 - 120
120 - 130
130 - 140
140 - 150
150 - 160
160 - 170
170 - 180
180 - 190
190 - 200
200 - 210
210 - 220
220 - 230
230 - 240
240 - 250
250 - 260
260 - 270
270 - 280
280 - 290
290 - 300
300 - 310
310 - 320
320 - 330
330 - 340
670,000
680,000
690,000
700,000
710,000
7,390,000
7,380,000
7,370,000
7,360,000
7,350,000
7,340,000
R8
Bonnie Doon
Mimosa
Burngrove Creek
Besgrove
R30
Deep Creek
Stewarton_North
Stewarton_South
Tannyfoil
Charlevue Creek
Ballamoo U.G.
South Ballamoo
Kenmare U.G.
Sirius Creek No. 1 U.G.
Laleham U.G.
Kenmare
R72
Bottom Dam
R74
Sirius Creek
Sirius Creek No. 2 U.G.
Blackwater Creek
Togara/North Marshme
Laleham
Augering U.G.
South Marshmead
Comet Downs East
Kennedy
0
2.5
5
km
Coordinate System: GDA2020 MGA Zone 55
Scale: 1:250,000 at A4
Project Number: 620.040199
Date Drawn: 21-May-2026
Drawn by: AS
LEGEND
Historical Underground Mine
Watercourse
Groundwater Level (mAHD)
BWM Mining Lease
GIA Study Area
Void Extent
Void Lake
Proposed Infrastructure Area
Proposed Open Cut Extension
BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT
PREDICTED GROUNDWATER LEVELS IN THE POLLUX SEAM (LAYER 12) – POST-MINING EQUILIBRIUM
SLR
DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.
FIGURE 8-36
Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F08_34_Predicted Groundwater Levels in the Pollux Seam (Layer 12) – PME



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	17-Sep-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Level (mAHD)
- BWM Mining Lease
- GIA Study Area
- Void Extent
- Void Lake
- Proposed Infrastructure Area
- Proposed Open Cut Extension

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

PREDICTED WATER LEVEL WITHIN BURNGROVE FORMATION (LAYER 16) – POST-MINING EQUILIBRIUM

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FIGURE 8-37

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F08_35_Predicted Groundwater Levels in the Burngrove Formation (Layer 16) – PME

8.2.5.2 Predictive Hydrographs Adjacent Void Lakes

Hydrographs showing the predicted change in groundwater levels over time for the shallow layers (Quaternary Sediments, Tertiary Sediments/Basalt and weathered regolith just outside of the residual voids are provided as **Appendix D**, with the hydrograph locations shown on **Figure 8-33**.

The vast majority of groundwater level drawdown in the Permian Coal Measures occurs pre-closure as a result of active extractive mining operations. Post-closure groundwater levels in the deeper coal seams recover from their lowest point that occurred during mining. However, most shallow groundwater units across the BWM Area show persistent drawdown post-recovery.

The hydrographs demonstrate very little effect on groundwater levels from the residual void inflow flux variability in the early post-closure period as shown and discussed in **Section 8.2.4**.

For most residual voids, lake levels remain below the base of weathering (regolith), except for Comet Downs East and R74 (as also presented previously on **Table 8-3**). However, the outflow from these lakes is captured by adjacent residual void lakes, as discussed in **Section 8.2.4** and further assessed in **Section 8.2.6.**

It should also be noted that, even if the hydrographs discussed above show that predicted groundwater levels just outside the residual voids can be relatively close to the predicted void lake levels for the Permian units, the potentiometric surface mapping (**Figure 8-33** to **Figure 8-37**) shows that only few hundred metres further distant from the residual voids, groundwater levels will be higher than the void lake levels, which will hydraulicly prevent any void lake from travelling any further than that, or in areas with flatter gradients, such as near Bonnie Doon, Stewarton South and Ramp 30, any outwards flux is recaptured by the voids in the long term post-mining due to the strong hydraulic gradients between adjacent voids. This is further demonstrated by the particle tracking in **Section 8.2.6**.

8.2.5.3 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 Project Area (refer **Section 5.2**). 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. The hydrographs are shown in **Figure 8-39** to **Figure 8-42** (Potential GDEs) and **Appendix E** (Third-Party bores) and locations shown in **Figure 8-38**.

Potential GDEs

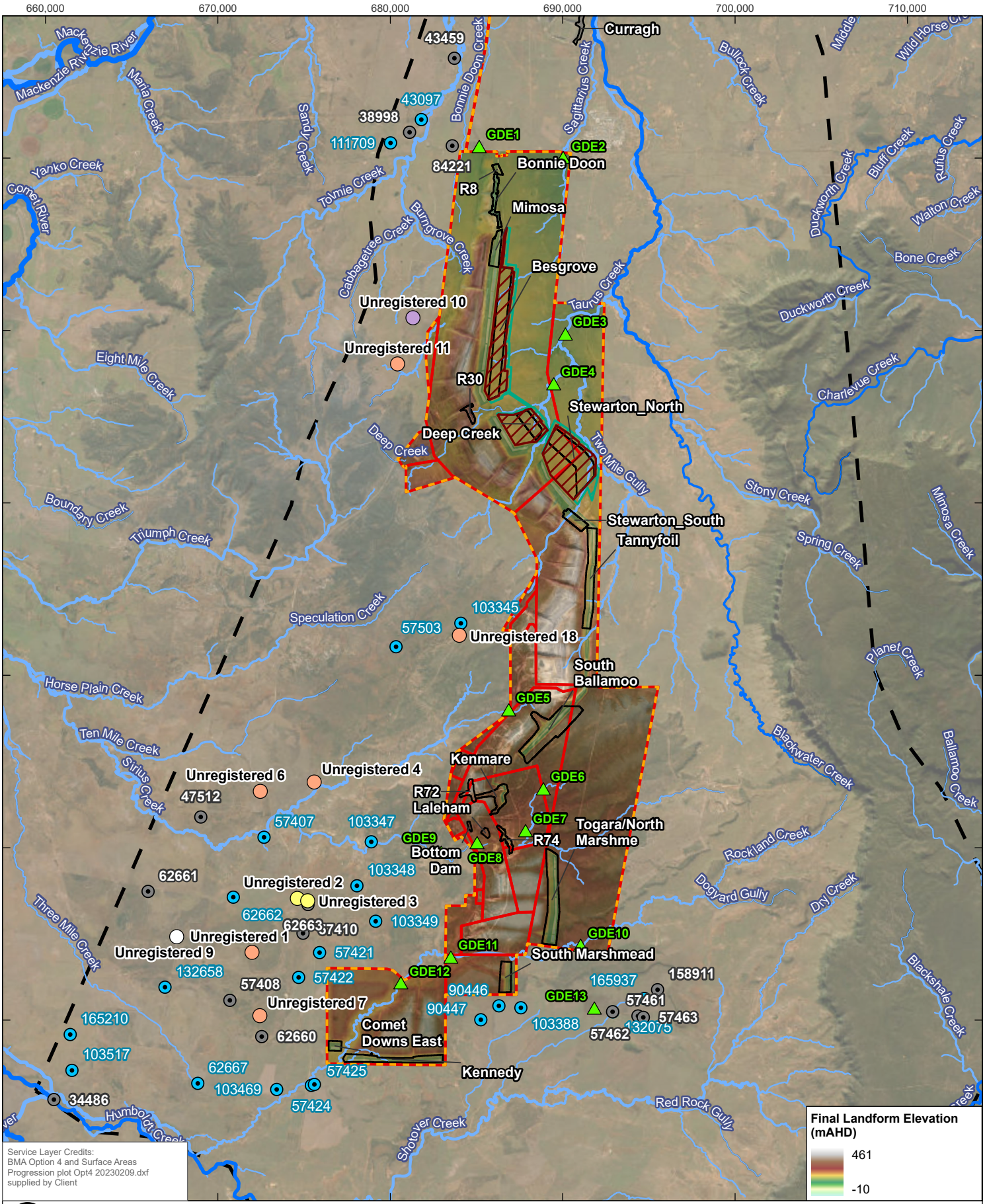
Predictive hydrographs for the water table at the potential GDE sites identified in and adjacent to the Project Area (refer **Section 5.2**) are shown in **Figure 8-39** to **Figure 8-42** with locations shown in **Figure 8-38**. The hydrographs indicate that several of the sites are unlikely to contain actual GDEs based on the significant predicted depth to groundwater of greater than approximately 8 to 10 m at those locations (sites GDE1 near Bonnie Doon Creek, GDE3 at Taurus Creek, GDE5 north of the Kenmare residual void, GDE6, GDE7 GDE8 and GDE9 near Sirius Creek, GDE11 at Rockland Creek, and GDE13 east of the South Marshmead residual void). That is, it is considered that a depth to groundwater table of 8 to 10 m or more is most likely too deep to be accessed by even the deepest-rooted terrestrial vegetation present, and therefore any vegetation present there would not be a GDE.



Of the potential GDE sites, GDE2 downstream Sagittarius Creek, GDE4 at Taurus Creek, and GDE10 and GDE12 downstream Rockland Creek show relatively shallow predicted water table depths.

The hydrographs indicate that much of the water table drawdown in the vicinity of potential GDEs is predicted to occur prior to the end of mining (i.e. associated with approved BWM mining operations), with any additional drawdown occurring over the post-mining period continuing the drawdown trends that commence prior to the end of mining. GDE10 is the only potential GDE to experience notable drawdown during the recovery simulation, with a decline in water level of up to approximately 12 m after the end of mining.

The shape of these hydrographs suggests that the additional drawdown impacts that occur in the post-mining period are residual impacts from approved active mining activities (i.e. a time lag from active mining), rather than new impacts caused by the PRC Plan's landform design; i.e. suggesting that the final landform is not contributing significantly to additional impacts at the potential GDE locations. This is a logical finding given that all residual voids are predicted to contain lakes with elevations significantly above the base of the void / maximum mining depth (refer **Section 8.2.6**).



Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:290,000 at A4
Project Number:	620.040199
Date Drawn:	21-May-2026
Drawn by:	RB

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

POTENTIAL RECEPTOR PREDICTIVE HYDROGRAPH LOCATIONS

SLR

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FIGURE 8-38

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F08_38_Potential Receptor Predictive Hydrograph Locations

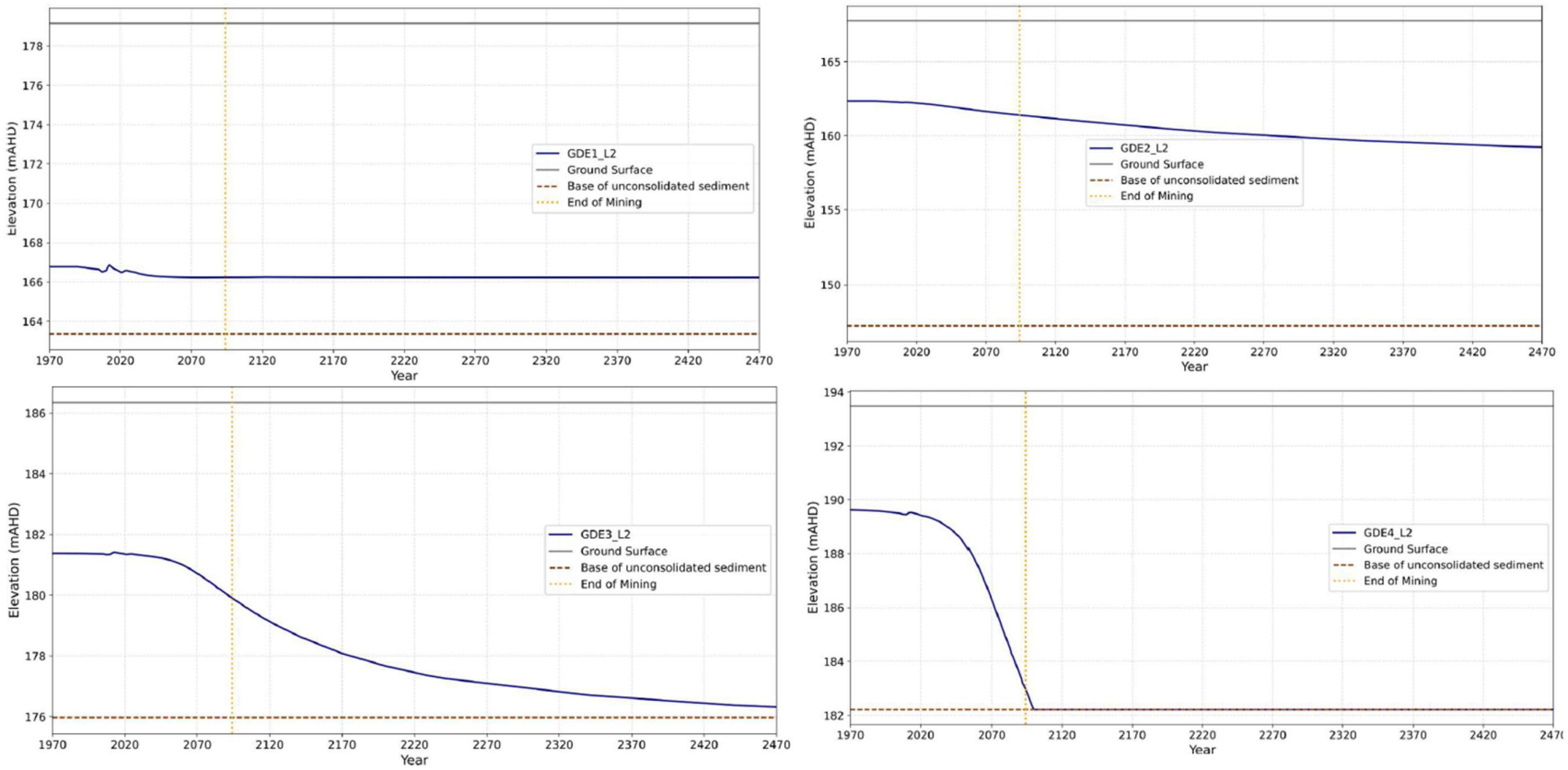


Figure 8-39 Water Table Hydrographs at Potential GDEs (GDE1 to GDE4)

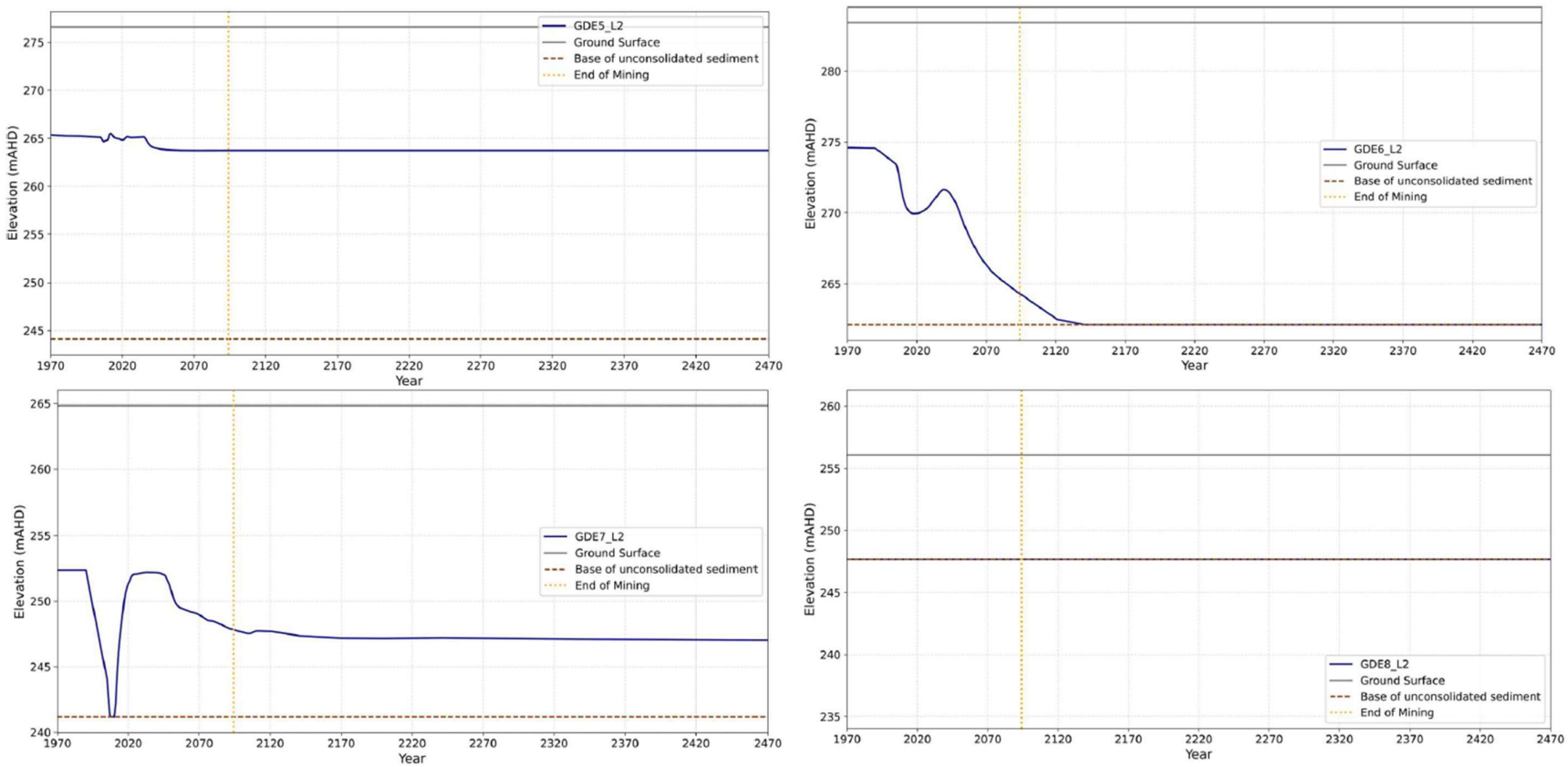


Figure 8-40 Water Table Hydrographs at Potential GDEs (GDE5 to GDE8)

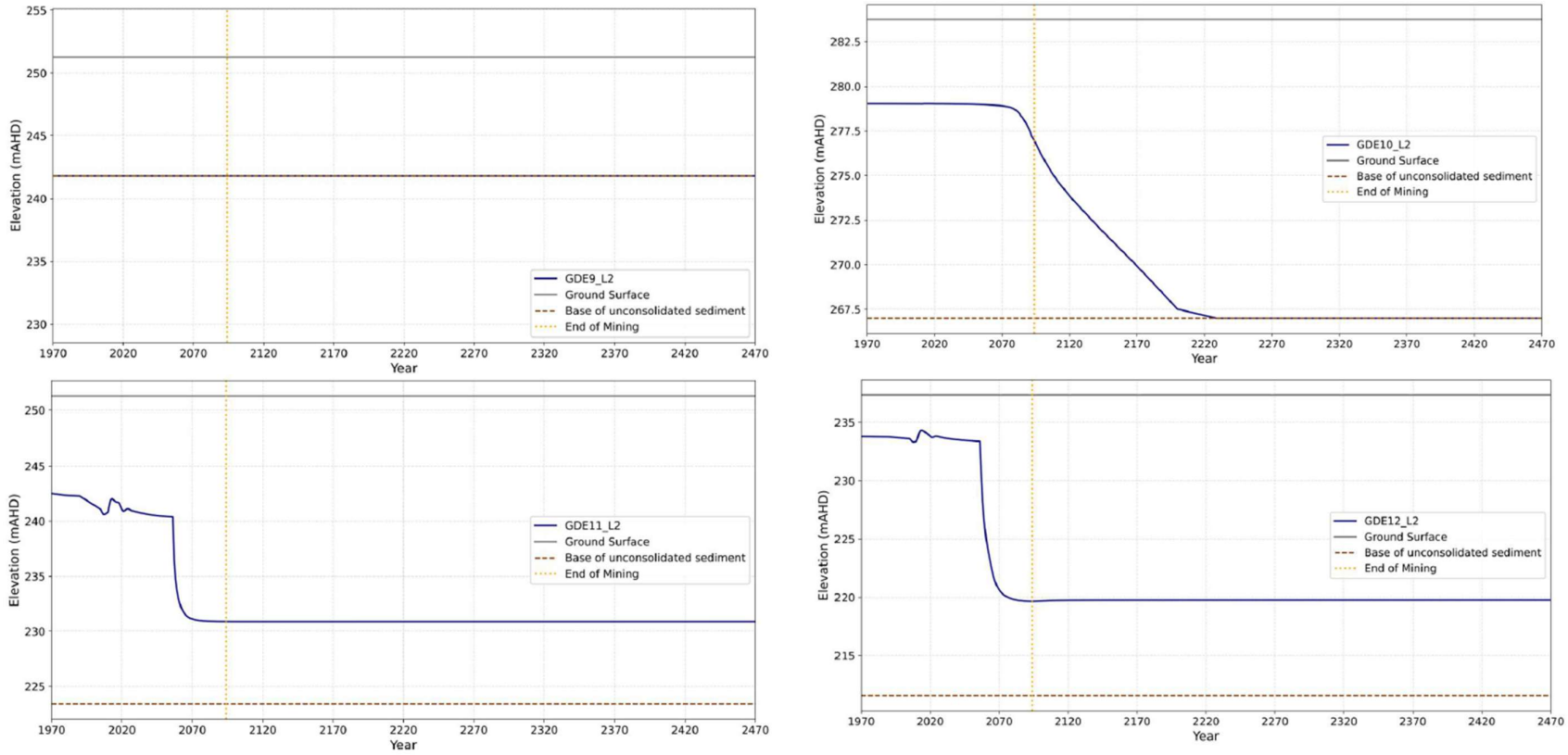


Figure 8-41 Water Table Hydrographs at Potential GDEs (GDE9 to GDE12)

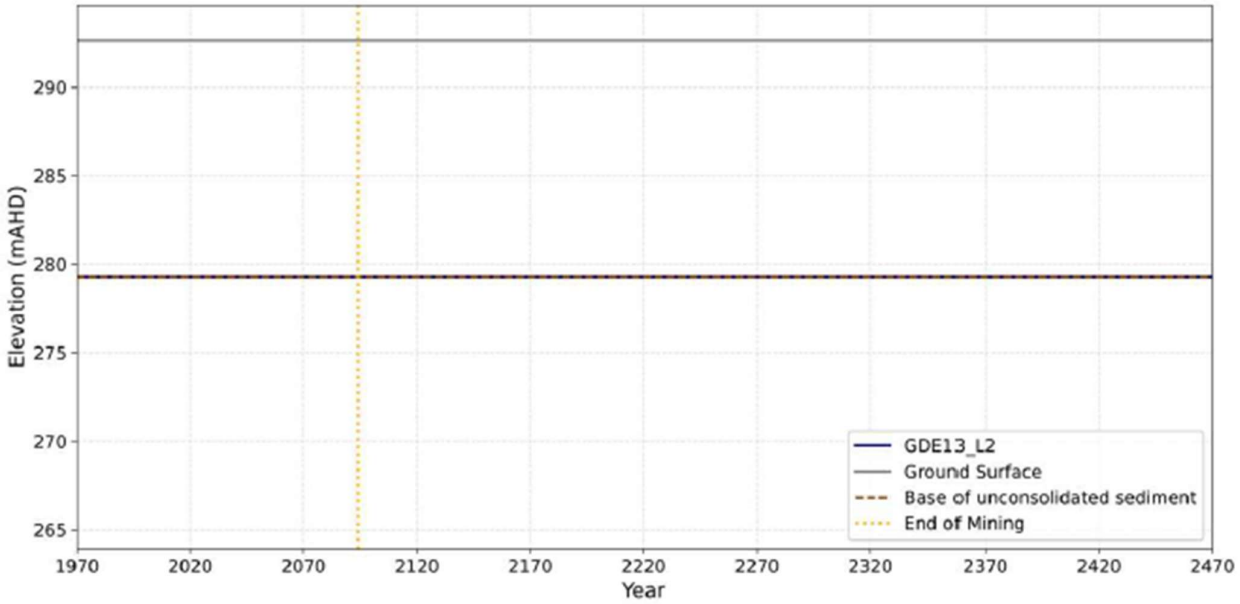


Figure 8-42 Water Table Hydrographs at Potential GDEs (GDE13)

Third Party Supply Bores

Predictive hydrographs for the 29 identified third party water supply bores surrounding the Project Area and within the Study Area with sufficient information to attribute a source aquifer (refer **Section 5.2.1**) are provided as **Appendix E** with locations shown on **Figure 8-38**. It is noted that bores interpreted to be screened in formations below the base of the groundwater model are not considered as they are interpreted to be below the base of the groundwater system that could be affected by BWM. The aim of the hydrographs is to assess the potential for additional impacts that may occur at these bores in the post-mining period. That is, to identify additional potential groundwater level impacts beyond those that have occurred during active mining operations through to closure in 2094, that may be attributable to the PRC Plans final landform.

As shown on the hydrographs of the bores interpreted to be in the weathered zone/regolith (model layer 2), no bore is predicted to experience additional groundwater drawdown over the post-mining period greater than the relevant 2 m drawdown 'bore trigger threshold' for unconsolidated aquifers identified in Chapter 3 of the *Water Act 2000* (Water Act).

The hydrograph for bore RN103388, interpreted to be in the Rewan Formation, shows a maximum of up to 13 m of additional drawdown predicted to occur during the post-mining period. This trend is interpreted to be a continuation of drawdown from approved mining but not an impact caused by the PRC Plan's final landform.

The hydrographs for bores RN57461, RN57462 also show groundwater levels in the Rewan Formation, as the interpreted model target layer (layer 2) is dry and hence the next layer down is included in the hydrographs so that a conservative assessment of potential impact can be undertaken. As shown on the hydrographs, up to 10 m to 15 m of additional drawdown is predicted to occur at these bores over the post-mining period. This trend is a continuation of drawdown from approved mining, not an impact caused by the PRC Plan's final landform.

As shown on the hydrographs for bores interpreted to be in Burngrove Formation, no bores are predicted with an additional post mining drawdown greater than the relevant 5 m drawdown 'bore trigger threshold' for consolidated aquifers identified in Chapter 3 of the Water Act 2000.

8.2.6 Flow Path Simulation

An analysis of the water movement within Landform 4.1 was undertaken to simulate and assess the movement and fate of water particles through the groundwater system post-mining.

8.2.6.1 Particle Tracking Setup

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. Papadopulos & Associates, Inc., 2018) was used to simulate particle pathways along the groundwater flow field post mining. To run the mod-PATH3DU code the transient head outputs from the groundwater flow model were used by mod-PATH3DU to simulate particle flow path lines.

Figure 8-43 shows the initial location of particles on Landform 4.1. With the exception of particles placed within the underground mine workings adjacent to Laleham, the particles were placed at the surface of the model 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. Mod-PATH3DU was configured to release the particles at the midpoint between the base of the first saturated layer and the water table. As



shown on **Figure 8-43** 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 BWM Area at the commencement of the post-mining simulation. The particles placed in the underground mines were configured to begin their simulation in the Pollux seam (Layer 12) to simulate the fate of water beginning in the flooded underground workings after mine closure.

8.2.6.2 Scenario 1 – Particles Released at the Commencement of Post-Mining

To estimate flow paths from the end of mining until post mining equilibrium, a first scenario was run with particles released at the start of the post mining period (year 2094) until the end of the post mining simulation period (year 4040).

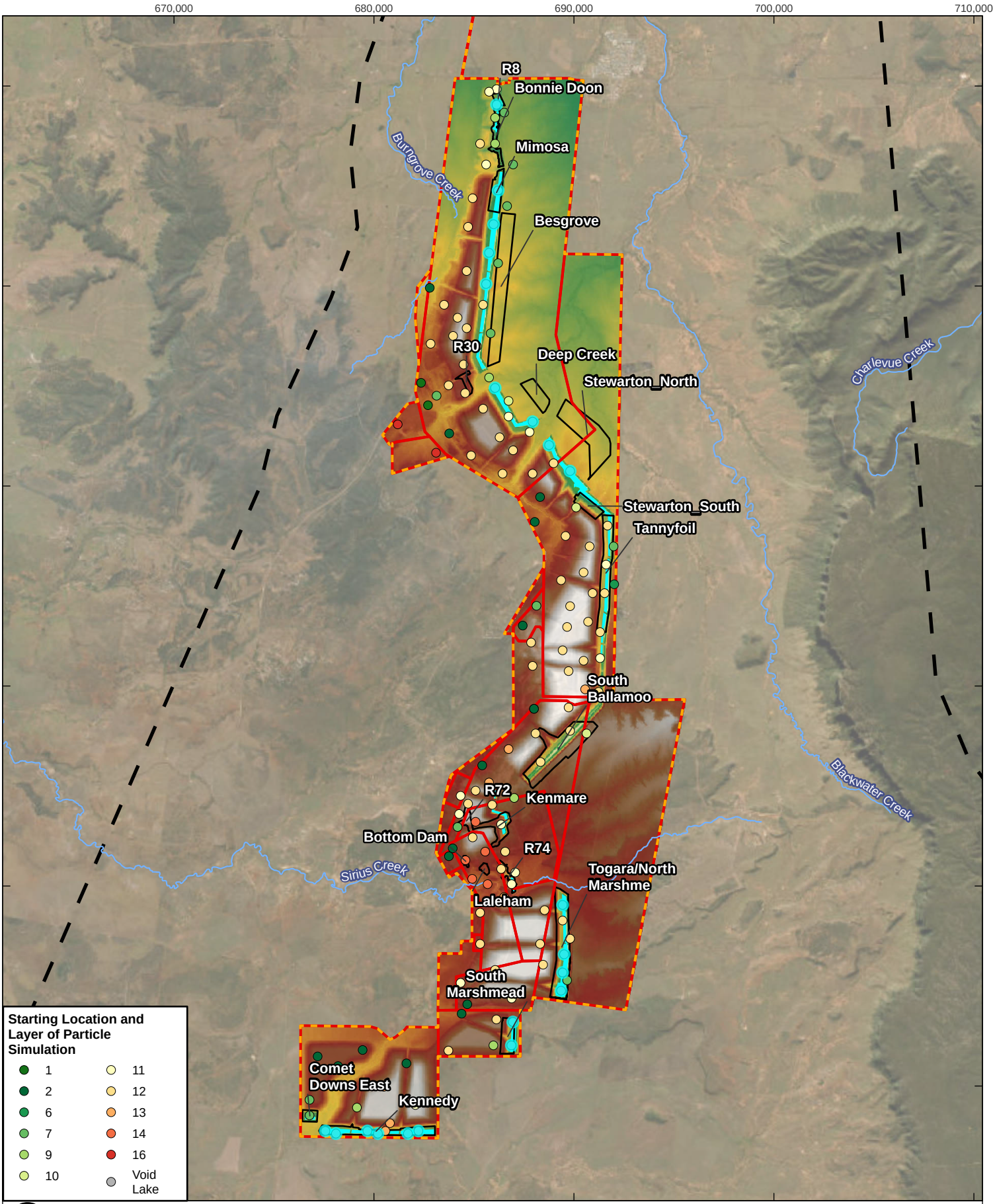
Figure 8-44 shows the predicted movement of water particles in the 1930-year post mining simulation of Landform 4.1. The colours along the predicted particle flow paths provide the model layer the particle was simulated to be moving through, with the green to red scale classification representing particles moving from shallow to deep model layers.

The colour changes along the paths on **Figure 8-44** 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. However, particles that begin in the Pollux seam (Layer 12) and other deeper layers often are observed to move upwards to shallower layers over the course of the recovery simulation, as the saturated water levels in the spoil and aquifers adjacent to the residual voids recover to their long-term post-mining equilibrium state. The flow path analysis indicates the particles generally move toward the void lakes, with all of the particles captured in the voids.

As discussed in **Section 8.2.4**, fluxes from voids that are predicted to act as a source to the local groundwater are toward neighbourhood voids. This can be observed in the particle movements shown on **Figure 8-44** with:

- particles released to the west of Ramp 30 moving toward Mimosa/Besgrove;
- particles released to the southwest of Ramp 30 moving toward Deep Creek;
- particles released to the north of Bonnie Doon moving toward Ramp 8; and
- particles released to the east of Ramp 74 moving toward Togara/ North Marshmead.

No particles are predicted to travel outside of the mine lease in the 1930-year post mining simulation.



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	22-Sep-2026
Drawn by:	AS

LEGEND

- Watercourse
- BWM Mining Lease
- Study Area
- Project Area (Environmental Authorities boundary)
- Void Extent
- Void Lake

Final Landform Elevation (mAHD)

461

-10

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

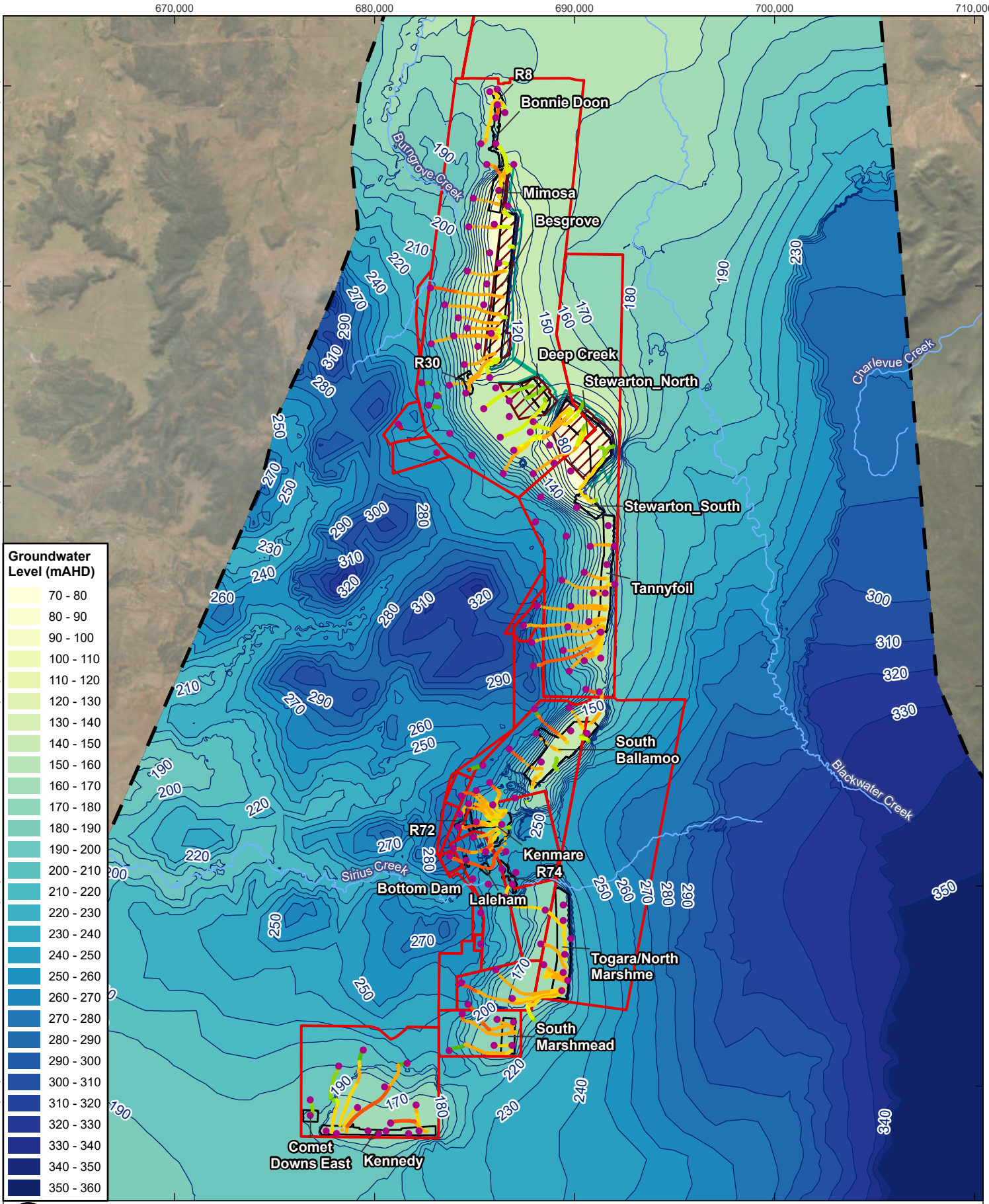
STARTING LOCATION OF PARTICLES

SLR

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FIGURE 8-43

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F08_41_Starting Location of Particles



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	21-May-2026
Drawn by:	AS

LEGEND

- Starting Location and Layer of Particle Simulation
- Watercourse
- Groundwater Level (mAHD)
- BWM Mining Lease
- Void Extent
- Void Lake
- GIA Study Area
- Proposed Infrastructure Area
- Proposed Open Cut Extension

Model Layer

1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

PREDICTED MOVEMENT OF PARTICLES (2094 - 4040)

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FIGURE 8-44

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F08_44_Predicted Movement of Particles Post Mining (2094 - 4040)

It is noted that some particles appear to not be moving on **Figure 8-44** (i.e. only the starting location is shown on **Figure 8-44** but there is no subsequent particle track). These particles have been released in areas where the water table is simulated to be relatively close to the model surface (i.e. within the evapotranspiration depth reach), and they have been "captured" by simulated evapotranspiration.

8.2.6.3 Scenario 2 – Particles Released at Post-Mining Equilibrium

To estimate flow paths at post mining equilibrium, a second particle tracking scenario was run with particles released at post mining equilibrium (year 2641) and run for 1300 years until the end of the post mining period in the model (year 4040). Year 2641 was selected based on the final void hydrographs (**Section 8.2.3**), where all final voids have reach equilibrium (i.e. flat lined).

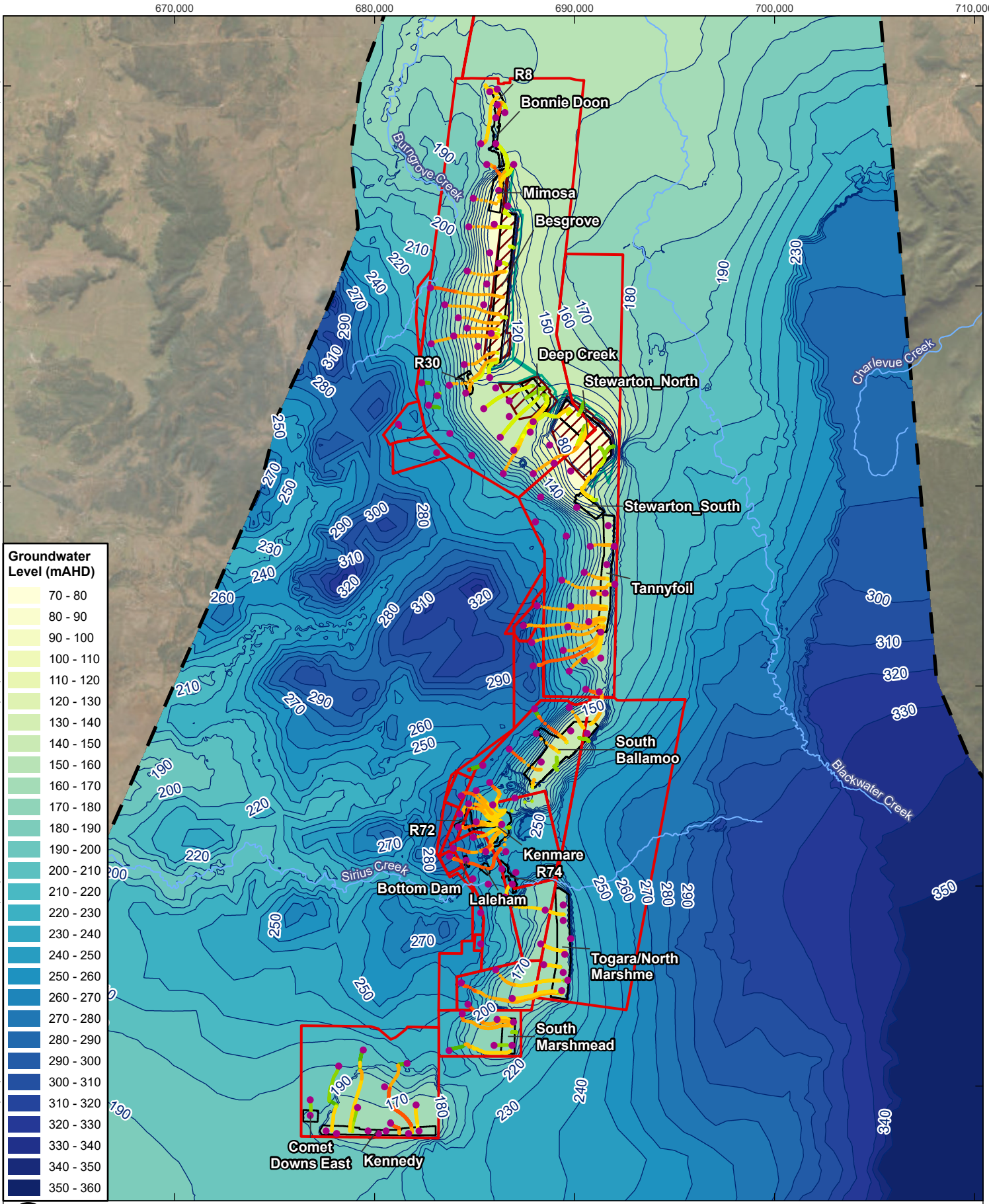
Results of the second simulation are shown on **Figure 8-45**. Differences in the flow path between particles starting at the end of mining (**Figure 8-44**) and particles starting at post mining equilibrium (**Figure 8-45**) are minimal. A comparison of the two results indicates some particles traveling a slightly different path, but destinations do not change. For particles still traveling at the end of the simulation (i.e. not captured by evapotranspiration or final void lakes), particles released at the end of mining travel a slightly longer distance (due to the longer simulation period).

Flow path descriptions and conclusions as presented for the post mining particle release time (**Section 8.2.6.2**) apply to the post mining equilibrium particle release time. No particles are predicted to travel outside of the mine lease in the 1300-year simulation.

8.2.6.4 Conclusion

Water associated with spoil and tailings deposition, underground mine workings or open cut residual void lakes is not predicted to migrate away from the BWM Area post mining, with the residual voids acting as passive containment for groundwater which has passed through the mine workings. This includes for the four residual voids predicted to have an outwards flux, with particle tracking simulations validating the outwards flux is driven by, and captured by, the adjoining residual voids with significantly lower lake levels.





0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	21-May-2026
Drawn by:	AS

LEGEND

- Starting Location and Layer of Particle Simulation
- Watercourse
- Groundwater Level (mAHD)
- BWM Mining Lease
- Void Extent
- Void Lake
- GIA Study Area
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Model Layer

1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

PREDICTED MOVEMENT OF PARTICLES (2641 - 4040)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE 8-45

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_F08_45_Predicted Movement of Particles Post Mining (2641 - 4040)

9.0 Conceptual Site Model - Post Mining

A visual representation of the post mining conceptual hydrogeological model following the groundwater modelling presented in **Figure 9-1** for the northern area of BWM and **Figure 9-2** for the southern area of BWM. It is an update to the preliminary assessment of potential impacts provided in **Section 7.2** utilising the modelling prepared for the PRC Plan.

Based on the understanding of hydrogeological mechanisms and groundwater modelling presented in this report, key features relevant to the discussion of potential groundwater impacts post-mining include:

- Residual void lake formation, with lake levels stabilising significantly below any shallow post-Permian strata, including the base of surficial weathering and shallow hydrostratigraphic units (i.e. alluvium and Tertiary strata) for most void except Comet East Downs.
- Partial groundwater system recovery outside the residual voids, primarily in the Rangal Coal Measures.
- Continued groundwater drawdown within the Rangal Coal Measures, associated with evaporative discharge from the void lakes, resulting in continued inwards hydraulic flow gradients in the coal measures and ongoing groundwater discharge to the residual voids, keeping the residual void lakes as groundwater sinks.
- Potential for ongoing salinization of the residual void lakes associated with evaporative discharge from the lakes.
- Reflooding of historical underground workings.
- No potential for groundwater quality impacts outside of the BWM Area associated with residual voids or spoil emplacements, due to the inward groundwater flow gradients towards the residual voids continuing to capture all potential seepage.
- No potential for groundwater quality impacts outside of the BWM Area associated with in-pit tailings emplacements at Bonnie Doon and Laleham, due to the inward groundwater flow gradients towards the residual voids continuing to capture all potential seepage.

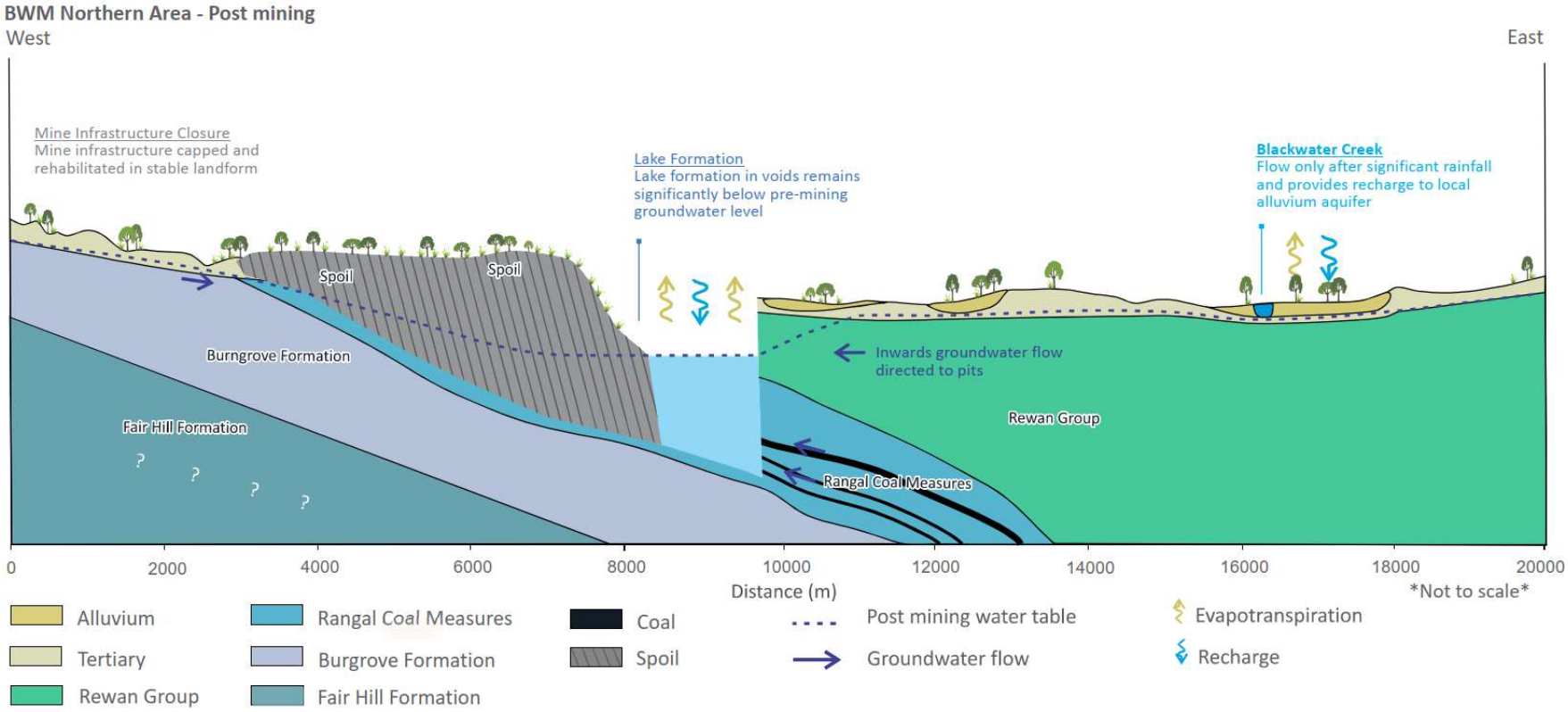


Figure 9-1 Conceptual Model of BWM Groundwater System – BWM Northern Area (Post Mining)

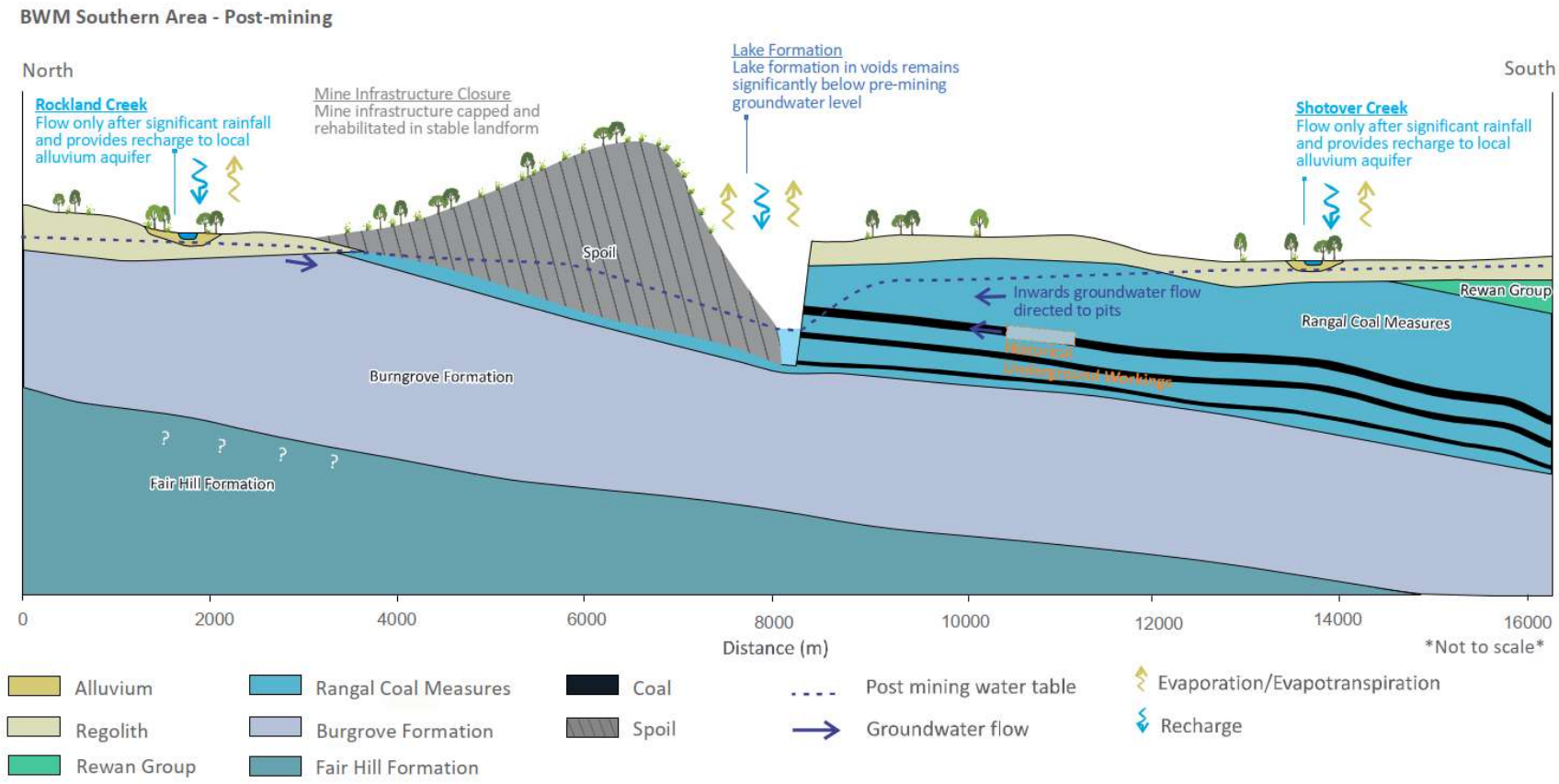


Figure 9-2 Conceptual Model of BWM Groundwater System – BWM Southern Area (Post Mining)

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Appendix A 80th Percentile Summary Statistics and Comparison to Guideline Values

Blackwater Mine

PRC Plan Hydrogeology Assessment – Revision 3

Whitehaven Blackwater Pty Ltd

SLR Project No.: 620.040199.00017

28 September 2026

Appendix A - 80th Percentile Summary Statistics and Comparison to Guideline Values

WQO Zone	Monitored Unit	Bore	pH (20th)	pH (80th)	TDS	EC	Ca	Cl	Na	Mg	SO4	Hardness as CaCO3	Alkalinity as CaCO3	HCO3	Nitrate as N	SiO2	Fluoride	Al (Diss)	Be (Diss)	B (Diss)	Cd (Diss)	Cr (Diss)	Co (Diss)	Cu (Diss)	Fe (Diss)	Pb (Diss)	Li (Diss)	Mn (Diss)	Hg (Diss)	Mo (Diss)	Ni (Diss)	Se (Diss)	Ag (Diss)	As (Diss)	U (Diss)	V (Diss)	Zn (Diss)
Units			-	-	mg/L	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Australian Drinking Water Guidelines (Aesthetic) (NHMRC, NRMMC, 2011)			6.5	8.5	600	-	-	250	180	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	1	0.3	-	-	0.1	-	-	-	-	-	-	-	3
Australian Drinking Water Guidelines (Health) (NHMRC, NRMMC, 2011)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	0.06	4	0.002	0.05	-	2	-	0.01	-	0.5	0.001	0.05	0.02	0.01	0.1	0.01	0.02	-	-
Aquatic Ecosystem (95% Protection) (ANZG, 2018)			6.5	8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	0.055	-	-	0.0002	0.001	-	0.0014	-	0.0034	-	1.9	0.0006	-	0.011	0.005	0.05	0.024	-	-	0.008
Irrigation (Fitzroy Basin WQO)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5	0.1	0.5	0.01	0.1	0.05	0.2	0.2	2	2.5	0.2	0.002	0.01	0.2	0.02	-	0.1	0.01	0.1	2
Stock (Fitzroy basin WQO)			-	-	5000	-	-	-	-	-	-	-	-	-	-	-	2	5	-	5	0.01	1	1	1	-	0.1	-	-	0.002	0.15	1	0.02	-	0.5	0.2	-	20
Zone 35 Shallow Groundwater (<30m)			7.59	7.93	-	1983	81	392	256	58	25	430	556	646	9.6	72	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zone 35 Deep Groundwater (>30m)			7.37	8.01	-	13604	366	5368	2555	226	122	1905	311	376	0.5	76	0.5	-	-	-	-	-	-	0.01	0.047	-	-	2.495	-	-	-	-	-	-	-	0.27
Zone 36 Shallow Groundwater (<30m)			7.7	8.35	-	7410	105	2373	1511	72	120	528	843	1021	7.5	60	0.39	-	-	-	-	-	-	-	0.02	-	-	0.07	-	-	-	-	-	-	-	-
Zone 36 Deep Groundwater (<30m)			8.21	8.66	-	7255	75	1945	1748	106	210	619	1322	1549	2.9	81	1.12	-	-	-	-	-	-	-	0.047	-	-	0.047	-	-	-	-	-	-	-	-
Zone 35 shallow	Alluvium	BWM_MB01_01	6.7	7.1	11400	21280	124.2	6005	3412	341	475		828.6	828.6	0.04		0.76	0.005	0.0005	2.04	0.0001	0.0005	0.0056	0.0016		0.0005	0.08	0.534	0.00005	0.004	0.005	0.005	0.0005	0.0014	0.0468	0.005	0.0536
Zone 35 shallow	Tertiary	BWM_MB15_01	3.1	3.2	3980	6354	14	1980	816	122	8		1	1	1.12		2.90	49.120	0.12	1.8	0.0004	0.012	0.06	0.063	0.184	0.011		0.2286	0.00005	0.0005	0.148	0.005	0.005	0.004	0.0070	0.005	0.195
Zone 35 shallow	Tertiary	BWM_MB17_02	7.2	7.3	363	570	8	60.8	118	6	10		194	194	0.01		0.7	0.011	0.00005	0.50	0.00005	0.0005	0.0005	0.0005	0.286	0.0005		0.144	0.00005	0.0024	0.006	0.005	0.005	0.002	0.0005	0.005	0.003
Zone 35 shallow	Tertiary	MB21	6.4	6.9	10300	14700	520.6	4806	2258	584	1944		573.6	574	0.01		0.20	0.010	0.0005	0.6	0.00005				3.056			0.3266	0.0001	0.001	0.004	0.01	0.001	0.002			0.017
Zone 36 shallow	Rewan Group	BWM_MB03_02	7.2	7.4		39140	1960	13000	6220	145	3							0.025		0.25					1.578			6.638	0.00025	0.0025	0.0214	0.025		0.0025			0.0241
Zone 36 shallow	Rewan Group	MB19BWM02A	6.2	6.4	29000	38000	1001.2	13500	7086	1064	511	6862	454	454	0.01	12.9	0.10	0.050	0.005	0.70	0.0005	0.005	0.005	0.031	0.368	0.005	0.14	0.103	0.00025	0.005	0.014	0.05	0.005	0.005	0.0025	0.050	0.2400
Zone 36 shallow	RCM north	BWM_MB02_01	6.668	6.7	18500	25080	608.6	8896	4076	607.4	372		346	346	0.01		0.05	0.005	0.0005	0.30	0.00005	0.0005	0.0005	0.0005	2.846	0.0005		0.597	0.00005	0.0005	0.0156	0.005	0.005	0.0025	0.0005	0.005	0.0156
Zone 36 deep	RCM north	MB1	6.55	6.8	26500	35800	756.8	12940	6886	704.4	372		368	368	0.01		0.05	0.050	0.0025	0.25	0.00025	0.0025	0.0025	0.0025	3.944	0.0025		0.144	0.0001	0.005	0.014	0.05	0.005	0.005	0.0025	0.025	0.0125
Zone 36 deep	RCM north	MB19BWM01P	6.992	9.8	16600	26000.6	243	9214	5800	138.4	7	1180	657	660	0.01	22.7	0.30	0.050	0.005	0.45	0.0004	0.004	0.004	0.005	1.548	0.004	1.21	0.121	0.0001	0.0336	0.005	0.035	0.0035	0.005	0.0013	0.050	0.072
Zone 36 deep	RCM north	MB19BWM27P	6.63	6.8	9348	14700.4	119	4440	3390	54	1	529	1896	1896	0.01	23.4	0.4	0.010	0.001	1.36	0.0002	0.001	0.007	0.0058	2.28	0.001	1.70	0.275	0.0001	0.004	0.013	0.01	0.001	0.0122	0.0005	0.010	1.292
Zone 36 deep	RCM north	MB20BWM03P2	6.89	7.0	12260	19820	167	6878	4276	104	3	957	584	584	0.01	20.8	0.4	0.005	0.0005	0.42	0.00005	0.0005	0.004	0.0164	1.288	0.0005	1.71	0.0968	0.00005	0.005	0.005	0.005	0.0005	0.0025	0.0020	0.005	0.3236
Zone 36 deep	RCM north	MB18	6.68	7.2	12160	17360	645.8	6370	2970	117	3		120	120	0.02		0.20	0.010	0.0005	0.48	0.00005	0.0005	0.0005	0.0005	2.558	0.0005		2.328	0.0001	0.001	0.009	0.01	0.001	0.001	0.007	0.0005	0.005	0.026
Zone 36 deep	RCM north	MB19BWM08P	7.446	7.6	3468	5411	33	1370	1216	6	2	109	788	799	0.01	17.8	0.50	0.010	0.001	1.56	0.0001	0.001	0.001	0.001	0.202	0.001	0.68	0.048	0.0001	0.003	0.003	0.01	0.001	0.001	0.0005	0.010	0.1216
Zone 36 deep	RCM north	BWM_MB02_02	8.08	9	10000	3420	8	715.6	704.4	6	4		17					0.008		1					0.06			0.011	0.00005	0.0268	0.0005	0.005	0.0005	0.002			0.0025
Zone 35 deep	RCM north	BWM_MB12_02	8.174	9.4		1952	14	423.8	405	6	25							0.009		0.20					0.062			0.003	0.00005	0.024	0.0005	0.005		0.004			0.0025
Zone 35 shallow	RCM south	BWM_MB14_01	6.5	6.6	13100	17780	374	5344	2784	717	1892		865.6	865.6	0.01		0.05	0.012	0.0005	0.80	0.00005	0.0005	0.002	0.0005	5.61	0.0005		1.418	0.00005	0.001	0.0192	0.005	0.0005	0.0066	0.0040	0.005	0.0158
Zone 35 deep	RCM south	BWM_MB14_02	7.6	7.7	4732	7408	7	1100	1980	8	26		2730	2856	0.01		1.8	0.014	0.0005	0.30	0.00005	0.0005	0.0007	0.0005	0.36	0.0005		0.011	0.00005	0.0005	0.001	0.005	0.0005	0.004	0.0005	0.005	0.0025
Zone 36 deep	Burngrove Formation	BG No.1 AP	7.17	7.9	4060	6950	37	1930	1504	21.6	28		670	691	0.01		0.60	0.010	0.0005	0.5	0.00005	0.0005	0.0005	0.0005	0.08	0.0005		0.017	0.0001	0.001	0.0005	0.01	0.001	0.001	0.0005	0.005	0.0060
Zone 36 deep	Burngrove Formation	BG No.2 BG	6.572	7.3	11140	17200	303.8	5238	3078	472.8	1510		875	875	0.01		0.20	0.010	0.0005	0.9	0.00005	0.0005	0.0005	0.0005	0.43	0.0005		0.195	0.0001	0.001	0.0348	0.01	0.001	0.001	0.0005	0.005	0.0025

Highlight cell indicates 80th Percentile is above criteria:

- Australian Drinking Water Guidelines (Aesthetic) (NHMRC, NRMMC, 2011)
- Australian Drinking Water Guidelines (Health) (NHMRC, NRMMC, 2011)
- Aquatic Ecosystem (95% Protection) (ANZG, 2018)
- Irrigation (Fitzroy Basin WQO)
- Stock (Fitzroy basin WQO)
- Zone 35 Shallow Groundwater (<30m)
- Zone 35 Deep Groundwater (>30m)
- Zone 36 Shallow Groundwater (<30m)
- Zone 36 Deep Groundwater (<30m)
- Multiple of above

Appendix B Groundwater Modelling Technical Report

Blackwater Mine

PRC Plan Hydrogeology Assessment – Revision 3

Whitehaven Blackwater Pty Ltd

SLR Project No.: 620.040199.00017

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Blackwater North Extension Project

Groundwater Modelling Technical Report

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Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Whitehaven Blackwater 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.

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1.0 Introduction

1.1 Background

SLR Consulting Australia Pty Ltd (SLR) was engaged by Whitehaven Blackwater Pty Ltd, a wholly owned subsidiary of Whitehaven Coal Limited to undertake a Groundwater Impact Assessment for the Blackwater North Extension Project (the Project), for incorporation into an application for an Environmental Authority (EA) Amendment and an application for an *Environment Protection and Biodiversity Conservation Act 1999* Approval.

The Project is an extension of mining into Surface Area (SA) 10 on Mining Lease (ML) 1759 and SA 7 on ML 1762 utilising existing Blackwater Mine (BWM) mining methods, mining fleet, mine infrastructure and facilities.

As part of the Groundwater Impact Assessment, a numerical groundwater model for the BWM has been developed to predict impacts of the Project on the local groundwater regime.

1.2 This Report

This report outlines the technical details of the BWM numerical groundwater model development to support the BWM groundwater assessment.

The conceptualisation provides a simplified overview of the groundwater regime (i.e., the distribution and flow of groundwater) based on available data and expert knowledge. Maintaining consistency between the numerical model results and the conceptual understanding of the groundwater regime enhances the credibility of the model's predictions. The numerical model presented in this report was developed in line with the conceptual framework described in the BWM Groundwater Assessment report (SLR, 2026).

1.3 Model Objectives

Numerical modelling was undertaken in support of the hydrogeological assessment to evaluate the potential impacts of the Project on the groundwater regime. The overall objectives of this modelling are to:

- Assess the groundwater inflow to the mine workings as a function of mine position and timing.
- Simulate the extent of maximum groundwater drawdown/depressurisation due to the Project and also with respect to cumulative impacts.
- Simulate and predict the change in groundwater levels at identified groundwater users (i.e. registered bores, landholder bores and groundwater dependent ecosystems [GDEs]) due to the Project and also with respect to cumulative impacts.
- Simulate the direct and indirect take of groundwater and surface water (baseflow) due to the Project.
- Simulate the long-term impacts in the post-mining environment utilising the proposed final landform and void lakes.



2.0 Model Construction

2.1 Model Code

MODFLOW-USG Transport was used as the model code (Panday et al. 2013). MODFLOW-USG is a recent version of industry standard MODFLOW code and was determined to be the most suitable modelling code for accomplishing the model objectives. MODFLOW-USG optimises the model grid and increases numerical stability by using unstructured, variably sized cells. These cells take any polygonal shape, with variable size constraints allowing for refinement in areas of interest.

Where previous MODFLOW versions restricted interlayer flow to vertical connectivity, MODFLOW-USG offers lateral connectivity between model layers. Lateral connectivity enables more accurate representations of hydrostratigraphic units, particularly those that pinch out, outcrop or cross geological faults.

MODFLOW-USG is also able to simulate unsaturated conditions, allowing progressive mine dewatering and post mining rewetting to be represented by the model. For the BWM model, vadose zone properties have been excluded, and the unsaturated zone was simulated using the upstream-weighting method.

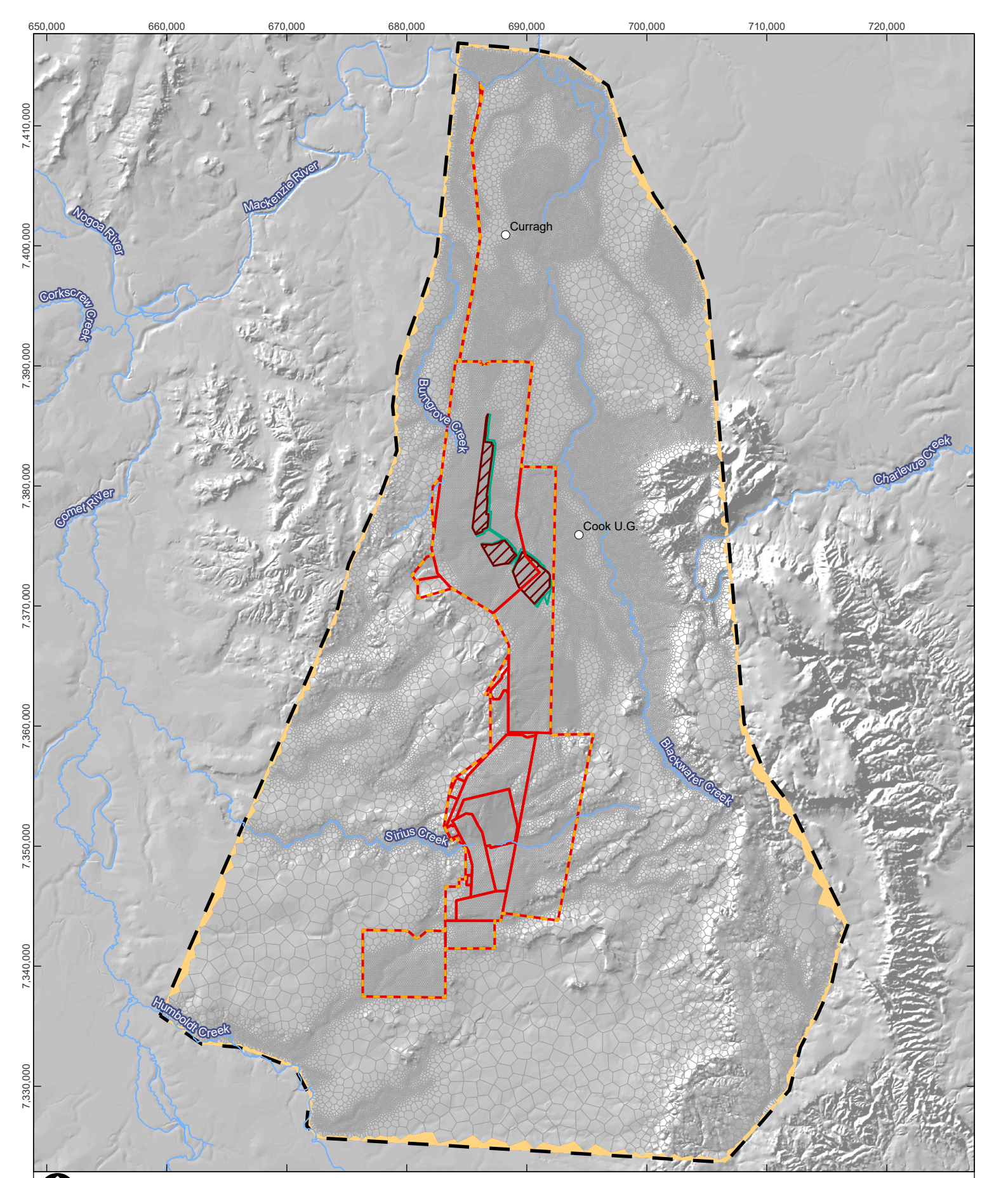
In-house Python codes and a MODFLOW-USG edition of the Groundwater Data Utilities (Watermark Numerical Computing) were used to construct the MODFLOW-USG input files.

2.2 Model Extent and Mesh Design

The model domain and mesh are presented on **Figure 2-1**. Both the northern and southern BWM geological models were adopted to set up the groundwater model layers. The model incorporates regional influences that have interacted with the local groundwater system in the past (during the calibration period) and may continue to interact with it in the future, including during the predictive mining and post-mining periods. These regional influences include operations at the Curragh Mine to the north (open cut) and underground mining at Cook Colliery to the east of BWM, both of which are considered to have a potential to interact with groundwater in the BWM area due to their proximity.

The model domain is intended to place boundary conditions sufficiently distant from the BWM site to allow the extent of potential impacts from mining activities on the groundwater system to be assessed. At its widest extents, the model is approximately 57 kilometres (km) west-east by 93 km north-south. The model domain was selected based on the following considerations:

- The western boundary is represented by the outcrop boundary of the Burngrove Formation, which underlies the Rangal Coal Measures (RCM) and is considered the basement formation for the purpose of this modelling.
- The northern boundary extends to include the open cut Curragh Mine and is 25 km north of the Project area.
- The southern boundary is set approximately 12 km south of the BWM site and is expected to be far outside the range of predicted BWM related drawdown.
- The eastern boundary is set along the Shotover fault which is located approximately 20 km to the east of the Project area. This boundary is expected to be far outside the range of predicted Project related drawdown.



0 5 10 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:400,000 at A4
Project Number:	640.031809.00001
Date Drawn:	16-Feb-2026
Drawn by:	RB

LEGEND

- Coal Mine
- Watercourse
- BWM Mining Lease
- Project Area (Environmental Authorities boundary)
- Model Boundary
- Model Grid
- General Head Boundary
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

MODEL MESH AND BOUNDARY CONDITIONS

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FIGURE 2-1

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F02_01_Model Mesh and Boundary Conditions

To allow stable numerical modelling of the large spatial area of the model domain, an unstructured grid with varying Voronoi cell sizes was designed using Algomesh (HydroAlgorithmics Pty Ltd, 2014). Varying Voronoi cell sizes allowed refinement around areas of interest, while a coarser resolution elsewhere reduces the total cell count to a manageable size. Compared with the previous model, the current mesh includes additional refinements around the bottom dam and underground mines. The refinement scale was also adjusted to ensure a reasonable total cell count.

Vertically, the model domain was vertically discretised into 17 layers, each layer comprising a cell count of up to 64,880. The total number of cells in the model is 815,467. This is after pinching out areas in layers 3 to 15 where layers are not always present based on the mapped geology. The current model also incorporates updated geological elevation data in South Blackwater, which were largely assumed in the previous model.

The following features have been included in the grid design:

- Open cut mining for the BWM including the historical mine and proposed extension is represented with a 150 metres (m) cell size constraint.
- Open cut mining for the historical Curragh mine is represented with a 200 m cell size constraint.
- Underground mining at Cook Colliery and Laleham projects has an oriented regular grid of 100 m width squares to represent longwalls.
- Underground mining at Sirius Creek No. 1 and 2 (ML 1771) are represented with a 50 m cell size constraint.
- Bottom dam area is represented with a 50 m cell size constraint.
- Alluvium areas are represented with a 200 m cell size constraint.
- Rivers, including major rivers and minor creeks and drains, are represented with a 100 m cell size constraint.
- The northwest-southeast striking faults within the model domain are represented with a 200 m cell size constraint.

2.3 Model Layers

The topography within the model domain has been defined using high-resolution (1 m) Digital Elevation Model data for pre-mining surface of the BWM area. Public domain 1-second Shuttle Radar Topography Mission data was used to define the topography in the remainder of the model domain.

The model domain is discretised into 17 layers, as listed in **Table 2-1**. Model layer extents (lateral and vertical) have been defined using data from the following sources:

- BWM site geological model.
- Commonwealth Scientific and Industrial Research Organisation (CSIRO) Regolith depth survey (Wilford et al, 2016).
- Queensland Globe bore hole logs.
- Queensland surface geology and basement geological maps.
- Office of Groundwater Impact Assessment (2019) model layers.

Layer 17 was designed as a basement layer to mitigate the risk of abnormal model behavior caused by the thin thickness of the Burngrove Formation in the western part of the model.



Table 2-1 presents the average thickness across the model domain for each layer.

Table 2-1 Model Layers and Thicknesses

Model Layer	Formation	Unit	Average Thickness (m)
1	Alluvium/Tertiary	Surface cover and Tertiary	8.5
2	Alluvium/Weathered zone	Weathered zone/Regolith	13.1
3	Clematis Group	Triassic	372.9
4	Rewan Group (Upper)	Triassic	309.4
5	Rewan Group (Middle)	Triassic	180.9
6	Rewan Group (Lower)	Triassic	114.9
7	RCM	Overburden	51.5
8		Aries seam	1.7
9		Interburden	15.2
10		Castor seam	1.7
11		Interburden	16.3
12		Pollux seam	4.2
13		Interburden	16.2
14		Orion seam	0.8
15		Underburden	17.9
16	Burngrove Formation	Permian	159.4
17	Basement	Permian and/or below	100.0

The regional site geology model (BM Alliance Coal Operations Pty Ltd, 25 m grid) provides the surfaces for tertiary and weathering zone within the BWM area. These surfaces were used to assign the bottom of layers 1 (i.e. Tertiary) and 2 (i.e. weathering) in the model. Outside the geology model extent, CSIRO Regolith survey depths (i.e. weathering depth) was used to define the base of layers 1 and 2. In doing so, the CSIRO Regolith depth was divided into two with each layer covering 50 percent (%) of total depth. Both Layers 1 and 2 are fully extensive across the model. The depth of alluvium was calculated from the site monitoring bores, drill holes, and available public Queensland Globe bore logs. Similar to weathering zone, layers 1 and 2 each cover 50% of total alluvium thickness, where present.

The underlying Rewan and Permian layers are present only to their outcrop extents, with some inference made for the presence of older units beneath the surface outcrop due to folding and faulting. The bottom of layers 3 to 16 was constructed based on the BWM geology model. Outside of the geology model extent, the surface geology map was used to define the location of outcrops of each unit. The average thicknesses were then extrapolated out into the extended model area to cover the layer outside the geology model.

As it is not practical to represent every individual coal seam in a regional groundwater model, a “combined thickness” totalling the individual seam thicknesses for each relevant seam has been simulated. The coal seams of the RCM were combined into four major coal seams: the Aries, Castor, Pollux and Orion seams.

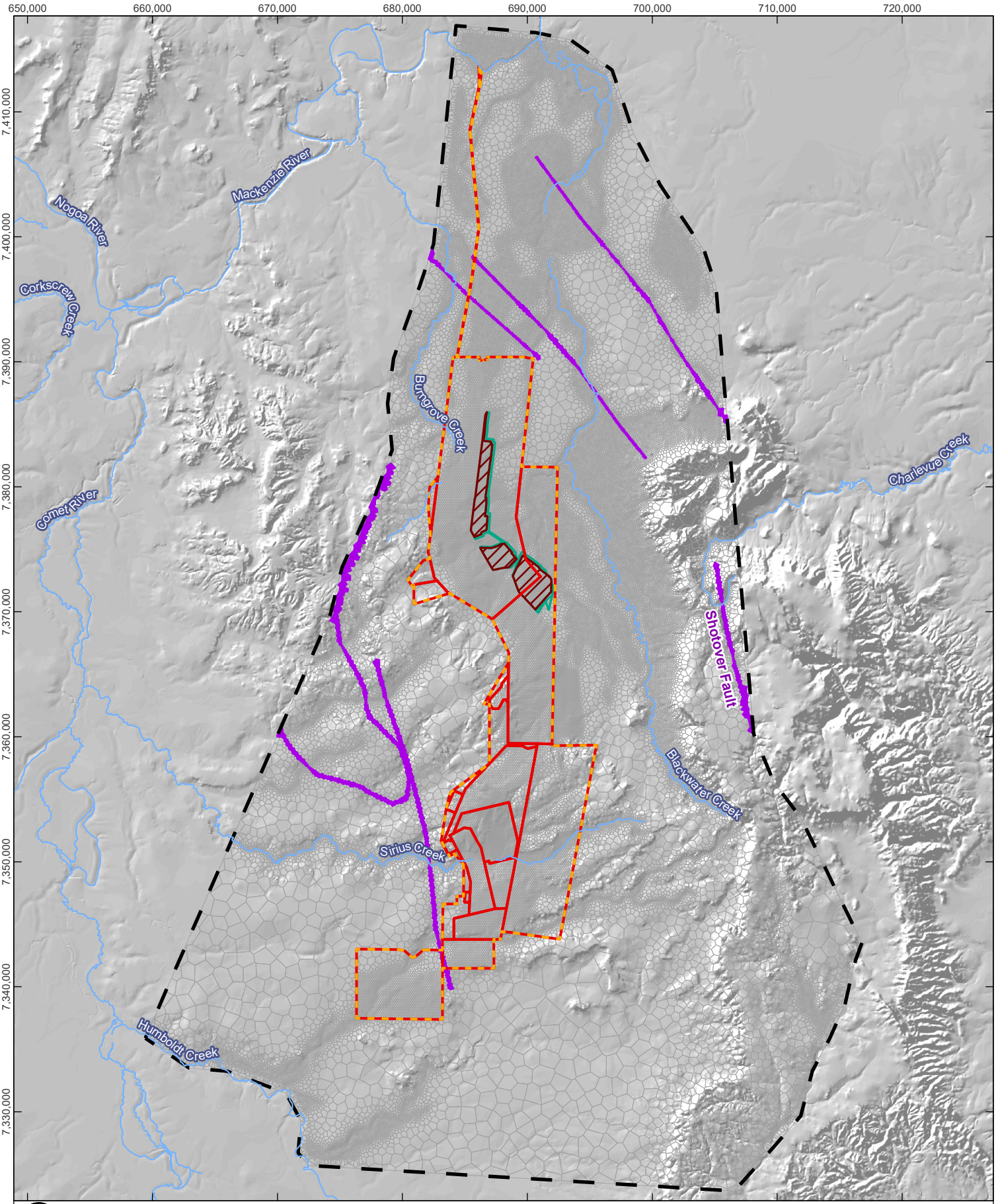
The Burngrove Formation is considered the regional low-permeability basement for the purpose of this modelling. However, due to its thin thickness in the western part of the model

and to prevent abnormal model behaviour, an extra layer, Layer 17, with a uniform thickness of 100 m, was added to define the base of the model and the western and eastern model boundaries.

2.3.1 Geological Structures

Mapped faults and geological structures in the vicinity of the Project area are shown in **Figure 2-2**. The most significant feature is the Shotover Fault, an east-dipping thrust fault with a displacement of up to 3,000 m (Mallet et al., 1988), located approximately 20 km east of the Project area and incorporated along the model's eastern boundary. Numerous smaller local faults are also mapped within the extent of the BWM and its proposed extension, with throws typically less than (<) 5 m, but reaching up to 20 m in some areas (Jeuken, 2011). These faults can fully offset coal seams and potentially act as barriers to groundwater flow, however, their hydraulic impacts are currently not well understood.

To reflect the structural complexity shown in **Figure 2-2**, the model grid was refined in areas where faults are present. While the faults were not assigned distinct hydraulic properties (e.g., reduced permeability or barrier features) due to the lack of site-specific hydrogeological data, their influence is implicitly incorporated through the layering and geometry in the refined grid. Should further data become available, the model could be updated to include fault-specific hydraulic characteristics.



LEGEND

- Watercourse
- BWM Mining Lease
- Project Area (Environmental Authorities boundary)
- Model Boundary
- Model Grid
- Fault Cell
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area

Coordinate System:	GDA2020 MGA Zone 55
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Drawn by:	RB

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

LOCAL AND REGIONAL FAULTS

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FIGURE 2-2

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F02_02_Faults in the Model

2.4 Timing

The model timing includes a combined transient warm up, steady state and transient calibration periods (**Table 2-2**).

To help with convergence in the steady state, a warmup transient stress period of 5 years from January 1966 to December 1969 was added to the timing as stress period 1. The calibration period includes a combined steady state (pre-mining) period and a transient historical period from January 1970 to January 2005. The transient calibration period runs from January 2005 to December 2024 with quarterly time intervals to replicate influence of historical mining.

To assist the model in overcoming numerical difficulties, MODFLOW-USG Adaptive Time-Stepping (ATS) option was used. The ATS option of MODFLOW automatically decreases time-step size when the run fails to converge. Once the run converged with a reduced time-step size, it increases the time-step size for the next time step to speed up the model run time. The minimum time step size used in the simulations was one day.

Table 2-2 Model Timing

Stress Period	Date Start	Date End	Mining Period	Max Stress Period Length (days)	Max Time Step Length (days)
1	01-01-1966	31-12-1969	Transient Warmup	1,460	1,460
2	-	-	Steady State	1	1
3 - 5	01-01-1970	31-12-2004	Historical	12,784	5,479
6 - 85	01-01-2005	31-12-2024	Calibration	7,305	92

2.5 Parameterisation

The modelled hydraulic zones are reflective of the conceptual (and geological) model. The site conceptualisation, as presented in SLR (2024), describes the hydraulic conductivity (K) data sources and the horizontal (Kx) and vertical (Kz) hydraulic conductivity parameter ranges for each stratigraphic unit as derived from field data. Overall, a broadly declining K with depth is noted for most of the solid geology stratigraphic units.

In the model, the decrease in hydraulic conductivity of the RCM, Rewan Group and Burngrove Formation is simulated to decrease exponentially with depth according to the following equation:

$$HC = HC_0 \times e^{(Slope \times dept\ )}$$

where: HC = horizontal hydraulic conductivity at the specific depth

HC_0 = horizontal hydraulic conductivity at depth of 0 m

Slope = term representing slope of the formula (steepness of the curve)

Depth = depth of the floor of the layer (thickness of the cover material)

Note: The hydraulic conductivity at zero depth (HC_0) is estimated in the calibration.

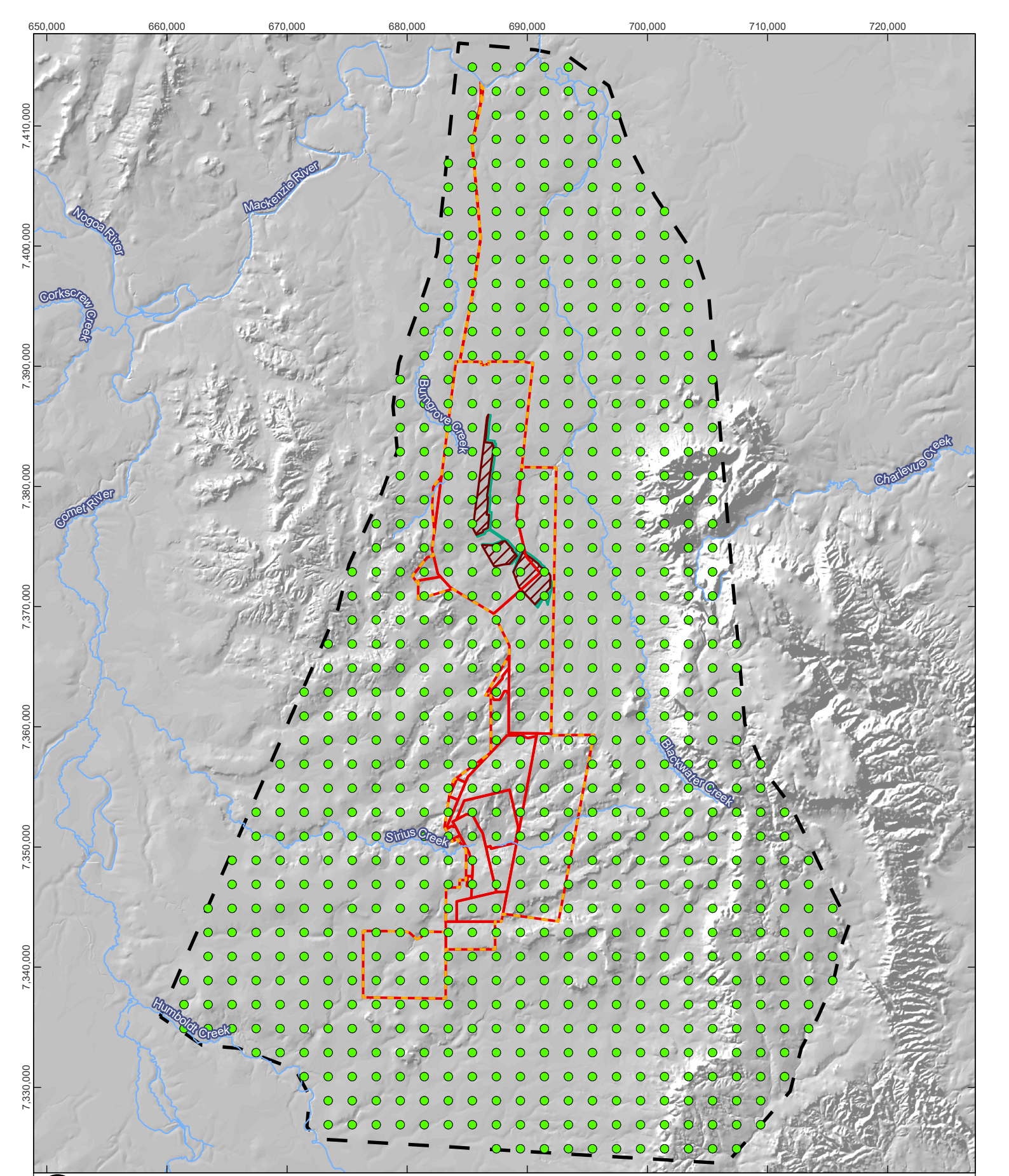
To allow spatial variability in unconsolidated units and the Clematis Group, pilot points were used from layer 1 to layer 3 (**Figure 2-3**). Pilot points were spaced uniformly. PEST++ use its PLPROC utility to interpolate between the pilot point values and creates a surface across the model domain for a targeted model parameter. This surface of model parameter values is then interrogated to provide a value at each model cell.

Hydraulic parameter zones and spatial variation options (e.g. pilot points, depth dependent equation or factor) are summarised on **Table 2-3**.

Table 2-3 Hydraulic Property Zones

Hydraulic Zone	Model Layer	Formation	Unit	Spatial Variation Options			
				Kx	Kz	Sy[1]	Ss[2]
1	1	Alluvium/Tertiary	Surface cover	Pilot Point	Pilot Point	Pilot Point	Constant
2	1	Regolith	Surface cover	Pilot Point	Pilot Point	Pilot Point	Constant
3	2	Alluvium/ Weathered zone	Surface cover	Pilot Point	Pilot Point	Pilot Point	Constant
4	2	Regolith	Surface cover	Pilot Point	Pilot Point	Pilot Point	Constant
5	3	Clematis Group	Triassic	Pilot Point	Pilot Point	Pilot Point	Constant
6	4	Rewan Group (Upper)	Triassic	Eq.1	Factor Kx	Constant	Constant
7	5	Rewan Group (Middle)	Triassic	Eq.1	Factor Kx	Constant	Constant
8	6	Rewan Group (Lower)	Triassic	Eq.1	Factor Kx	Constant	Constant
9	7	RCM	Overburden	Eq.1	Factor Kx	Constant	Constant
10	8	RCM	Aries seam	Eq.1	Factor Kx	Constant	Constant
11	9	RCM	Interburden	Eq.1	Factor Kx	Constant	Constant
12	10	RCM	Castor seam	Eq.1	Factor Kx	Constant	Constant
13	11	RCM	Interburden	Eq.1	Factor Kx	Constant	Constant
14	12	RCM	Pollux seam	Eq.1	Factor Kx	Constant	Constant
15	13	RCM	Interburden	Eq.1	Factor Kx	Constant	Constant
16	14	RCM	Orion seam	Eq.1	Factor Kx	Constant	Constant
17	15	RCM	Underburden	Eq.1	Factor Kx	Constant	Constant
18	16	Burngrove Formation	Permian	Eq.1	Factor Kx	Constant	Constant
19	17	Burngrove Formation	Permian	Eq.1	Factor Kx	Constant	Constant

1 Sy = Specific yield
2 Ss = Specific storage



0 5 10 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:400,000 at A4
Project Number:	640.031809.00001
Date Drawn:	16-Feb-2026
Drawn by:	RB

LEGEND

- Pilot Point
- Watercourse
- BWM Mining Lease
- Project Area (Environmental Authorities boundary)
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

PILOT POINTS LOCATIONS

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FIGURE 2-3

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F02_03_Pilot Points Used in the Model

2.6 Model Stresses and Boundary Conditions

2.6.1 Regional Groundwater Flow

General Head Boundaries (GHB) have been specified along the perimeter of the model domain, as represented in **Figure 2-1**.

The GHB boundary condition was used to represent regional groundwater inflow and outflow across the model domain. GHB cells were assigned along the perimeter of the model area in all layers except where river cells are present. For each GHB cell, the head was estimated during the steady state calibration.

Groundwater enters the model where the GHB head exceeds the modelled head in the adjacent cell and leaves the model when the water level is lower in the GHB. GHB conductance is calculated using the hydraulic conductivity and the dimensions of each GHB cell and is therefore variable in this model due to variable cell size.

2.6.2 Watercourses

2.6.2.1 Natural Watercourses

The largest local creek (Blackwater Creek), along with selected higher-order tributaries, was incorporated into the model using the MODFLOW-USG River (RIV) package. The rivers within the model that were included in the RIV package are presented in **Figure 2-4,** and were categorized into 10 zones based on their scales and spatial distribution within the model domain. Only higher-order streams were included in the RIV package to represent the primary surface water–groundwater interactions. Lower-order stream segments were not incorporated. As a result, some streams (e.g., Rockland Creek) appear to terminate at or near the mine lease boundary in the model representation.

River boundaries were also applied to the southwestern and southeastern parts of the model where the boundary cells intersect with Humboldt Creek and Planet Creek, both of which are tributaries of the Fitzroy River.

After reviewing water stage data from several stations via the Water Monitoring Information Portal, it was determined that all rivers within the model domain are ephemeral. Consequently, the stage level was set to 0 for all river cells, effectively replicating the behaviour of the DRN package. River widths were assumed to be fixed for each river in the model. The river conductance was calculated using river width, river length, riverbed thickness, and the vertical hydraulic conductivity of riverbed material (**Table 2-4**).

2.6.2.2 Mining Infrastructure

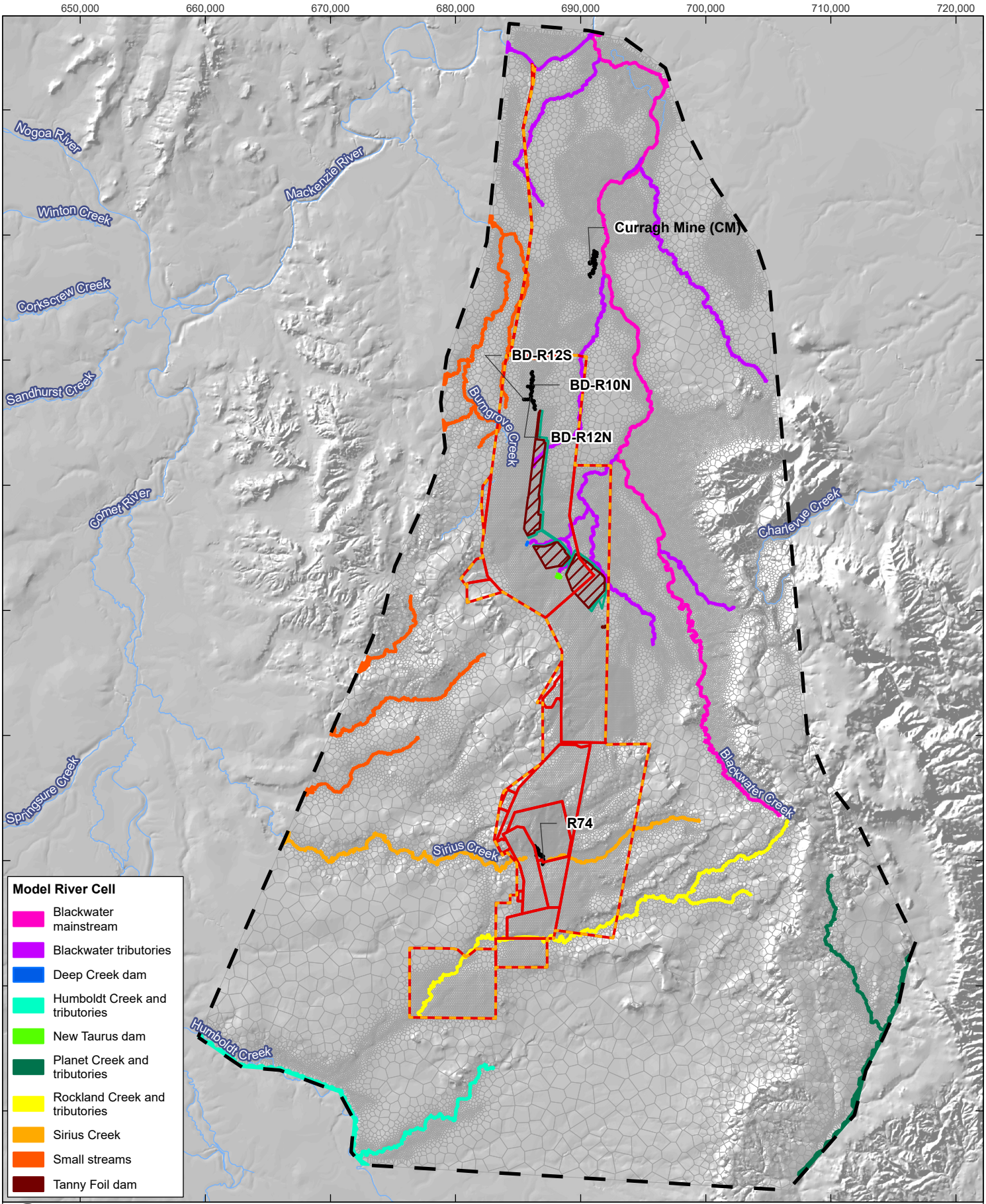
The RIV package was also used to represent dams and tailing storage facilities within the area, with dams presented in **Table 2-4.** Tailings dams are listed **Table 2-5** and their location is presented on **Figure 2-4**.

Table 2-4 River and Surface Water Features in the Model

Zone	Vertical K (meters per day [m/day])	River Width (m)	River Bed Thickness (m)	Name
1	0.05	5	1	Blackwater mainstream
2	0.05	1	1	Blackwater tributaries
3	0.05	2	1	Sirius Creek
4	0.05	1	1	Rockland Creek and tributaries
5	0.05	1	1	Humboldt Creek and tributaries
6	0.05	1	1	Planet Creek and tributaries
7	0.05	1	1	Small streams
8	0.001	1	1	Deep Creek dam
9	0.001	1	1	New Taurus dam
10	0.001	1	1	Tannyfoil dam

Table 2-5 Mining Infrastructure in the Model

Tailing Dams	Kz (m/day)	Stage
BD-R10N	5.0×10^{-1}	Deposited from July 2023 until 2040
BD-R12N	5.0×10^{-1}	Deposited from July 2023 until 2040
BD-R12S	5.0×10^{-1}	Deposited from July 2023 until 2040
R74	5.0×10^{-1}	Deposited from Jan 2025 until 2040
Curragh Mine (CM)	5.0×10^{-1}	Deposited from Jan 2007 until 2023



0 5 10 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:400,000 at A4
Project Number:	640.031809.00001
Date Drawn:	16-Feb-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Project Area (Environmental Authorities boundary)
- Model Boundary
- Model Grid
- TSF Cell
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

RIVER CELLS

SLR

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FIGURE 2-4

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F02_04_River Cells

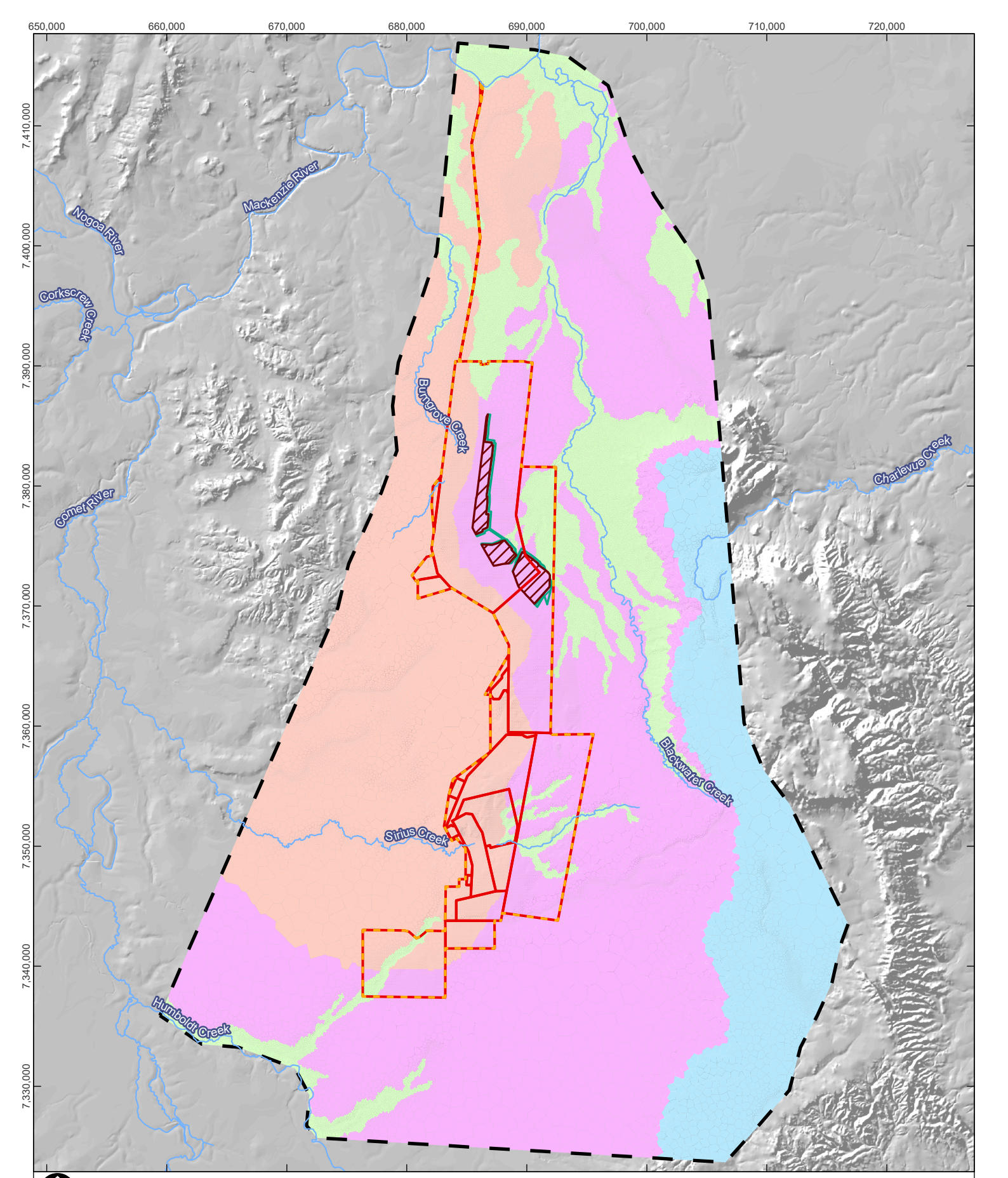
2.6.3 Rainfall Recharge

Diffuse infiltration of rainfall through the soil profile and subsequent deep drainage to underlying groundwater systems were represented using the MODFLOW-USG Recharge package (RCH). For the period from January 1970 to December 2024, recharge rate data was sourced from the Bureau of Meteorology's Australian Water Resources Assessment Landscape model, which simulates deep drainage, and introduces seasonality to the modelled recharge rates for the quarterly stress periods used during calibration. The recharge rate for the steady state condition was calculated using the long-term average daily recharge rate from January 1911 to December 1967. For the subsequent stress periods, daily recharge rates were calculated based on the average daily recharge rate over the corresponding date range within each stress period.

Multipliers were then utilised during the calibration process. Separate multipliers are used for each recharge zone. Rainfall recharge was imposed as a percentage of actual rainfall from the Scientific Information for Land Owners (SILO) Grid Point observations. Long-term average rainfall was used for the steady-state model. The historical rainfall data were averaged on an annual basis (2000 to 2004) and on a quarterly basis (2004 to 2024) for the transient calibration model. Also, the averages of the historical rainfall data from 1980 to 1990 and from 1990 to 2000 were used for these periods. For the predictive model, long-term average rainfall was used.

The model includes 4 recharge zones, as presented in **Figure 2-5**:

- Zone 1 - Quaternary Alluvium.
- Zone 2 - Regolith.
- Zone 3 - Weathered Clematis.
- Zone 4 - Weathered Permian.



0 5 10 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:400,000 at A4
Project Number:	640.031809.00001
Date Drawn:	16-Feb-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Project Area (Environmental Authorities boundary)
- Model Boundary
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area

Recharge Zone

- Zone 1 - Quaternary Alluvium
- Zone 2 - Regolith
- Zone 3 - Weathered Clematis
- Zone 4 - Weathered Permian

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

MODELLED RECHARGE ZONES

SLR

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FIGURE 2-5

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F02_05_Recharge Zones

2.6.3.1 Mining Induced Recharge

Enhanced recharge via spoil was simulated by progressively introducing a fifth recharge zone for the spoil. That zone expands as mining progresses and spoil is deposited in the open cut pits.

The calibrated recharge rates for all zones are discussed in **Section 3.4.3.1**.

2.6.4 Evapotranspiration

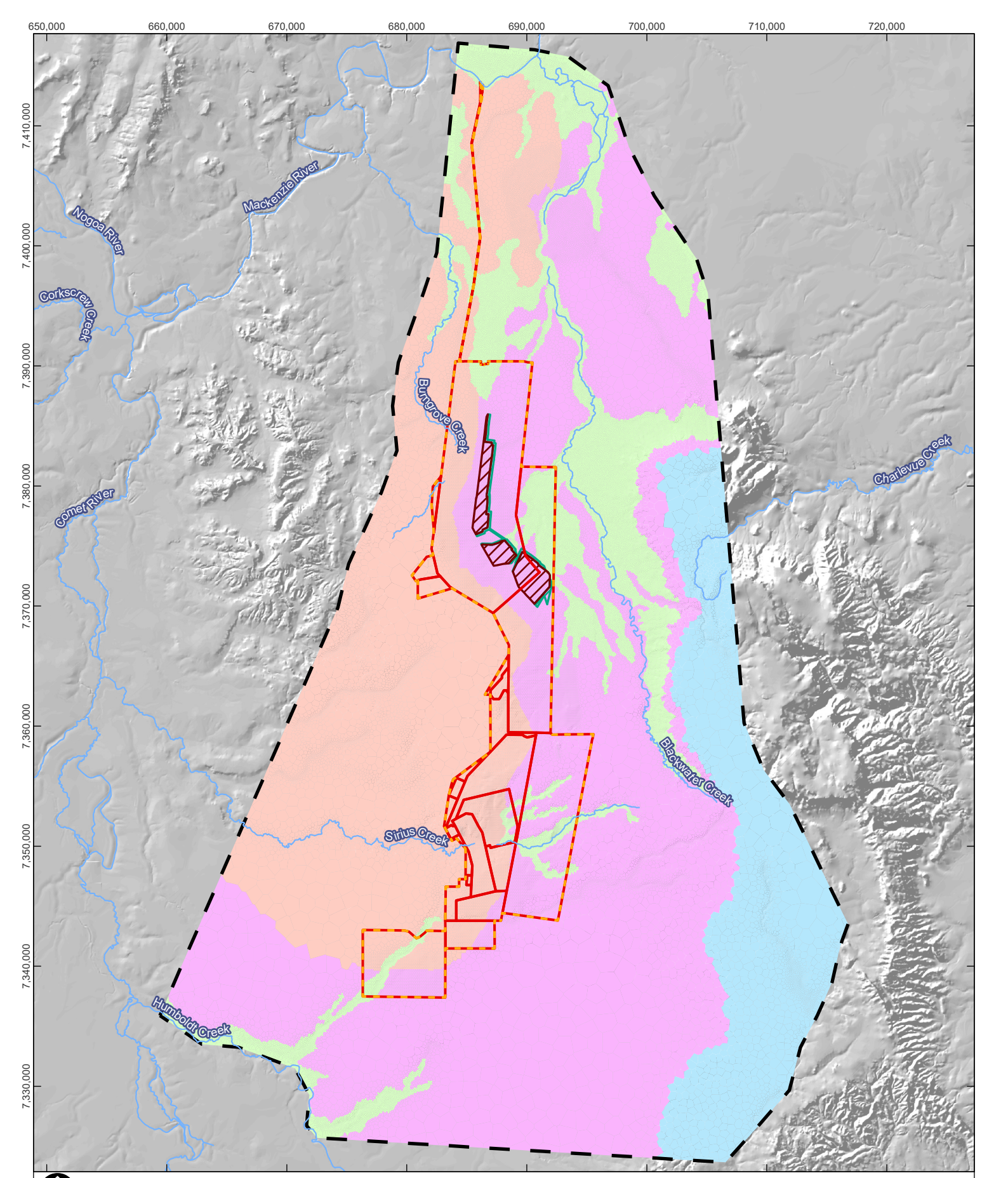
Evapotranspiration (ET) from the shallow water table was simulated using the Evapotranspiration package (EVT). ET was represented in the upper most cells of the model domain, with the extinction depth varied spatially based on the estimated rooting depths of regionally vegetation type.

In this model, EVT is excluded from cells that also contain RIV or GHB conditions. This approach is taken to avoid double-counting groundwater discharge in locations where other boundary conditions already represent flow out of the aquifer. Applying EVT in the same cells could result in non-physical water losses and distort the water balance by allowing multiple boundary conditions to compete for the same volume of groundwater. Excluding these cells from the EVT zone ensures that each type of boundary condition represents a distinct and non-overlapping physical process.

Same zones as recharge were assigned as EVT zones (refer to **Figure 2-6**):

- Zone 1 - Quaternary Alluvium.
- Zone 2 - Regolith.
- Zone 3 - Weathered Clematis.
- Zone 4 - Weathered Permian.

The maximum ET rate was derived from the SILO Grid Point series (Queensland Government, 2023). A single value of 0.0045 m/day was applied in the model for the steady-state and initial stress periods preceding the calibration period, and also the predictive period. Varied rates were applied to the calibration periods, while a single value was used for the first two stress periods, as well as the predictive period. An ET rate of zero was assigned to model cells representing rivers.



0 5 10 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:400,000 at A4
Project Number:	640.031809.00001
Date Drawn:	16-Feb-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Project Area (Environmental Authorities boundary)
- Model Boundary
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area

Recharge Zone

- Zone 1 - Quaternary Alluvium
- Zone 2 - Regolith
- Zone 3 - Weathered Clematis
- Zone 4 - Weathered Permian

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

EVAPOTRANSPIRTION ZONES

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FIGURE 2-6

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F02_05_Recharge Zones

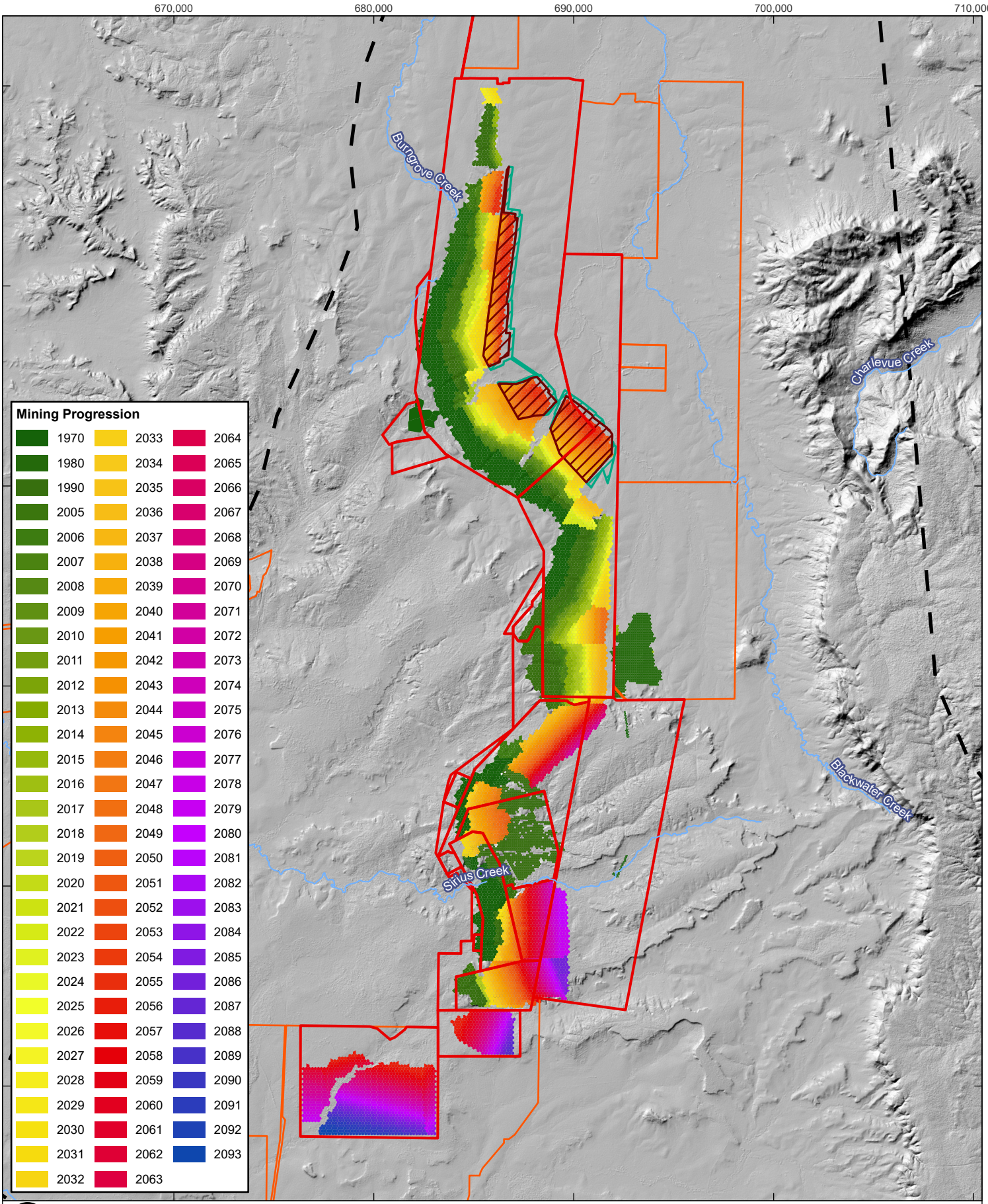
2.6.5 Mining

All mines included in this assessment, namely BWM, BWM South (Kenmare and Laleham), Cook Collieries, and Curragh Mines are targeting the RCMs, hence a cumulative assessment of impacts is carried out. The location of both the open pit and underground mines is shown in **Figure 2-7**.

2.6.5.1 Dewatering

The MODFLOW Drain (DRN) package is used to simulate mine dewatering in the model for the Project and surrounding mines. Boundary conditions for drain cells allow one-way flow of water out of the model. When the computed head drops below the pre-defined stage elevation of the drain, the drain cells become inactive. This is an effective way of theoretically representing removal of water seeping into a mine over time, with the actual removal of water being via pumping and evaporation.

To simulate BWM open cut pits in the model, drain cells are applied to all active layers from the surface to the base of the lowermost mined seam, which is the Pollux seam (Layer 12). The drain cells representing the surrounding open cut mines were interpolated from previous reports, publicly available Environmental Impact Statement documentation and aerial photography.



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	16-Feb-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area
- Study Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

MINING PROGRESSION

SLR

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FIGURE 2-7

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F02_07_Mining Progression

2.6.5.2 Variation in Hydraulic Properties due to Mining

Two types of mining have been considered; open cut and underground.

For open cut mining, Hawkins (1998) and Mackie (2009) indicate that spoil and waste rock are more permeable than the undisturbed strata. Completed open cut mining areas will be backfilled with waste overburden as the extraction proceeds. Backfilling of open cut mine areas with spoil was modelled using the MODFLOW-USG Time-Variant Material (TVM) package. The model cell properties were updated to spoil properties guided by operational mine plans. Horizontal hydraulic conductivity, vertical hydraulic conductivity, specific yield and specific storage of the spoil were adjusted during the calibration process. Hydraulic conductivity (Kx and Kz) change within the stress period when mining (DRN) is activated, and storage properties are activated in the stress period when DRNs become inactive

Several tailings storage areas were defined by the proponent, with tailing hydraulic properties applied in the model and adjusted during the calibration process.

For the underground mines, the hydraulic properties were changed with time in the goaf and overlying fractured zone directly above each longwall panel. The TVM package was used to simulate changes to aquifer properties in response to mining within the overlying strata and fracture zone. Calculated multipliers were used to enhance hydraulic conductivities within the fracture zone overlying coal extraction areas, with multipliers generally following a ramp function, so that the multipliers with highest values are applied to the units closest to the mined seam and then gradually decrease as the units become close to the maximum height of connective cracking. The fracture zone multipliers are listed in **Table 2-6**.

The maximum height of connective cracking was derived using the Ditton/Merrick equation (Ditton and Merrick, 2014). The fracture heights over the Pollux seam in the underground mines ranged from 57 m to 154 m, with an average fracture height of 119 m and no fracturing of the surface is expected.

Table 2-6 Fracture Zone Multipliers

Layer	Unit	Average Kx Multipliers	Average Kz Multipliers
1	Alluvium/Tertiary	1	1
2	Alluvium/Weathered zone	1	1
6	Rewan Group (Lower)	1	1
7	RCM - Overburden	44	51
8	RCM - Aries seam	6	30
9	RCM - Interburden	1	2
10	RCM - Castor seam	1	1.3
11	RCM - Interburden	12	295

3.0 Calibration

3.1 Calibration Method

Automated calibration utility PESTPP-IES (White et al, 2020) was used to match the available water level data. The numerical algorithm that is implemented by PESTPP-IES is referred to as an “iterative ensemble smoother”. The job of an ensemble smoother is to assimilate data in a “batch” sense. To accomplish this, PESTPP-IES begins the model parameterisation process with a collection of random parameter fields drawn from the prior parameter probability distribution. Through a series of iterative adjustments, PESTPP-IES modifies the parameter realisations that make up the ensemble to satisfy calibration constraints. The results presented in this section are from the realisation that yielded the lowest simulated error (sum of squares). However, where possible, results have been provided for all realisations within the ensemble. The model variables included in the calibration were:

- Aquifer parameters, including horizontal and vertical hydraulic conductivity, specific storage and specific yield by zone.
- Pilot point multiplications for horizontal and vertical hydraulic conductivity, and specific yield.
- RCH rate factors by zone.
- EVT rate factors and extinction depths by zone.
- Vertical conductivity of RIV cells. Additionally, tailing dams were modelled using the RIV package, with their vertical hydraulic conductivities also parameterized.
- Hydraulic properties of spoils and tailings, including horizontal and vertical hydraulic conductivity, specific storage, and specific yield, with vertical conductivity linked to horizontal conductivity.

The calibration methodology for the BWM model involved running the model numerous times with different parameter sets to identify those that yielded the best calibration statistics. The process began with 500 initial realisations, sampled within the defined parameter ranges by PESTPP-IES. After 10 iterations, 75 realisations were optimized to achieve satisfactory calibration performance. The ensemble size was deemed sufficient based on a review of uncertainty convergence on predicted fluxes (**Section 7.1**)

The calibration statistics were calculated for each realisation and the realisation that produced the lowest Scaled Root Mean Square (SRMS) error was considered to be the best-calibrated model for the purposes of the BWM. This model is referred to as “Best Calibrated Model” (BCM) and calibration results are presented for the BCM herein.

3.2 Calibration Dataset

The groundwater levels recorded between Aug 2009 to Dec 2024 were used as calibration targets. They were processed into two groups – initial water level and drawdowns from the initial water levels for each bore. In all, 1,789 observation targets, including 108 initial heads and 1,681 drawdowns, were established for 108 bores from the BWM area.

Groundwater targets were selected where valid information on bore construction or geology information was available for the site. Targets were manually reviewed to ensure the measurements were realistic.

Details on each of the observation points are presented in **Appendix A** of this report.



3.2.1 Groundwater Levels

Table 3-1 summarizes the initial groundwater levels measured from 108 observation points, which have been used as the first group of calibration targets for the groundwater model. The groundwater levels from various geological formations, including the weathered zone, Rewan Group, RCM overburden/interburdens and RCM coal seams.

Table 3-1 Summary of Initial Groundwater Levels used for Calibration Targets

Model Layer	Target Unit	Number of Bores
2	Weathered zone/Regolith	18
5	Rewan Group (Middle)	1
6	Rewan Group (Lower)	6
7	RCM Overburden	14
8	Aries seam	13
9	RCM Interburden	3
10	Castor seam	9
11	RCM Interburden	3
12	Pollux seam	18
13	RCM Interburden	1
14	Orion seam	2
16	Burngrove Formation	20
	Total	**108**

3.2.2 Drawdown

Table 3-2 summarizes the drawdowns used as calibration targets for the groundwater model. These values are derived by subtracting the initial groundwater level from the subsequent measurements taken from the same observation bores. A total of 1,681 drawdowns across 107 bores were converted from the measured water levels. The data spans multiple geological layers, including the weathered zone, Rewan Group, RCM overburden/interburdens, RCM coal seams and Burngrove Formation, offering a comprehensive view of the groundwater system's response.



Table 3-2 Summary of Drawdowns Used for Calibration Targets

Model Layer	Target Unit	Number of Bores	Number of Observations
2	Weathered zone/Regolith	18	167
5	Rewan Group (Middle)	1	7
6	Rewan Group (Lower)	6	137
7	RCM Overburden	14	433
8	Aries seam	13	354
9	RCM Interburden	3	74
10	Castor seam	9	95
11	RCM Interburden	3	38
12	Pollux seam	18	190
14	Orion seam	2	21
16	Burngrove Formation	20	165
	Total	**107**	**1681**

3.2.3 Calibration Weighting

During calibration, each groundwater bore in each group (initial water level or head difference) was assigned a base weight of 1, and the weight for each observed target was calculated as $1/\sqrt{n}$, where n is the total number of observations recorded at that bore.

3.3 Calibration Performance

3.3.1 Calibration Statistics

An industry-standard approach for assessing the calibration of a model is to analyse statistics related to the calibration. One way of doing this is by comparing the simulated differential (i.e. error) between the simulated and observed (measured) water levels, which is often expressed as the root mean square (RMS). The RMS value is calculated by taking the square root of the mean of the squared differences between the simulated and observed water levels. RMS is expressed as:

$$\mathrm{RMS} = \left[\frac{1}{\mathrm{n}}\sum(\mathrm{h_o} - \mathrm{h_m})_\mathrm{i}^{\,2}\right]^{0.5}$$

where: n = number of observations

h_o = observed water level

hm = simulated water level

Another option for measuring the goodness of fit is the SRMS error. SRMS is computed by dividing the RMS by the range of measured heads and expressing it as a percentage. When the goal is to fit historical measurements of water levels, SRMS provides a valuable indicator of the goodness of fit (Barnett et al., 2012). This is primarily due to its ability to compare errors in the simulated values against the total head changes in the system. If the errors are small relative to the total head change, they can be considered negligible.

The PESTPP-IES ensemble calibration process was initiated with 500 randomly generated realisation and 75 calibrated realisations from the final iteration were retained as sufficient for assessing uncertainty in the quantities of interest (QOIs). A summary of statistical analyses of the error residual between simulated and observed water level elevation for all calibrated realisations is provided in **Table 3-3.**

Although there is no universal recommendation for an acceptable SRMS error, Barnett et al. (2012) suggest that establishing SRMS targets, such as 5% or 10%, may be appropriate in certain circumstances. In this study, RMS error calculated for the Best Calibrated Realisation within the ensemble is 11.6 m. The total measured head change across the model domain is 177.3 m, leading to a SRMS value of 6.6%. For the ensemble, the maximum SRMS is 7.4% (**Table 3-3**).

Figure 3-1 presents the observed and simulated groundwater levels graphically as a scattergram for the historic transient calibration (1990 to 2024), for the BCM. As can be seen in **Figure 3-1**, hydraulic gradients are well reproduced across the calibration dataset.

Table 3-3 Calibration Statistics

Statistic	Minimum	Median	Maximum	Best Calibrated Realisation
Mean Residual (m)	1.3	3.7	5.5	3.8
Mean Absolute Residual (m)	8.8	9.3	10.2	9.1
Standard Deviation (m)	10.9	11.5	12.6	11.0
Sum of Squares (square metres [m^2])	242581.2	259575.5	308003.7	242581.2
RMS error (m)	11.6	12.1	13.1	11.6
Minimum Residual (m)	-51.6	-33.3	-26.5	-30.2
Maximum Residual (m)	29.0	33.1	39.4	34.2
Number of Observations	1789	1789	1789	1789
Range in Observations (m)	177.3	177.3	177.3	177.3
Scaled Standard Deviation (%)	6.2	6.5	7.1	6.2
Scaled Absolute Mean (%)	5.0	5.3	5.8	5.1
SRMS (%)	6.6	6.8	7.4	6.6

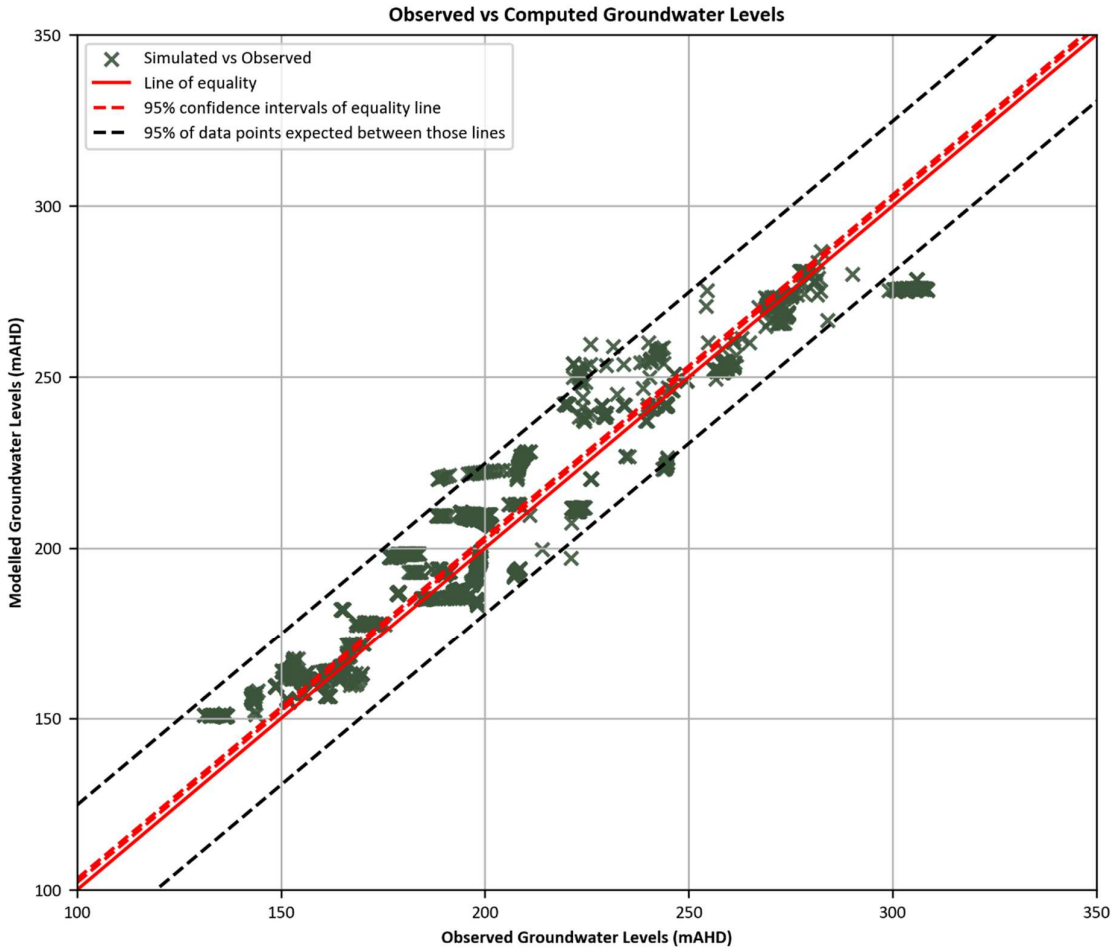


Figure 3-1 Calibration Scattergram

Figure 3-2 shows the distribution of calibration residuals for the BCM. As shown in the figure the calibration residuals in majority of the calibration data points are within ± 10 m. **Figure** 3-2 indicates that in general, the model tends to slightly overpredict groundwater levels.

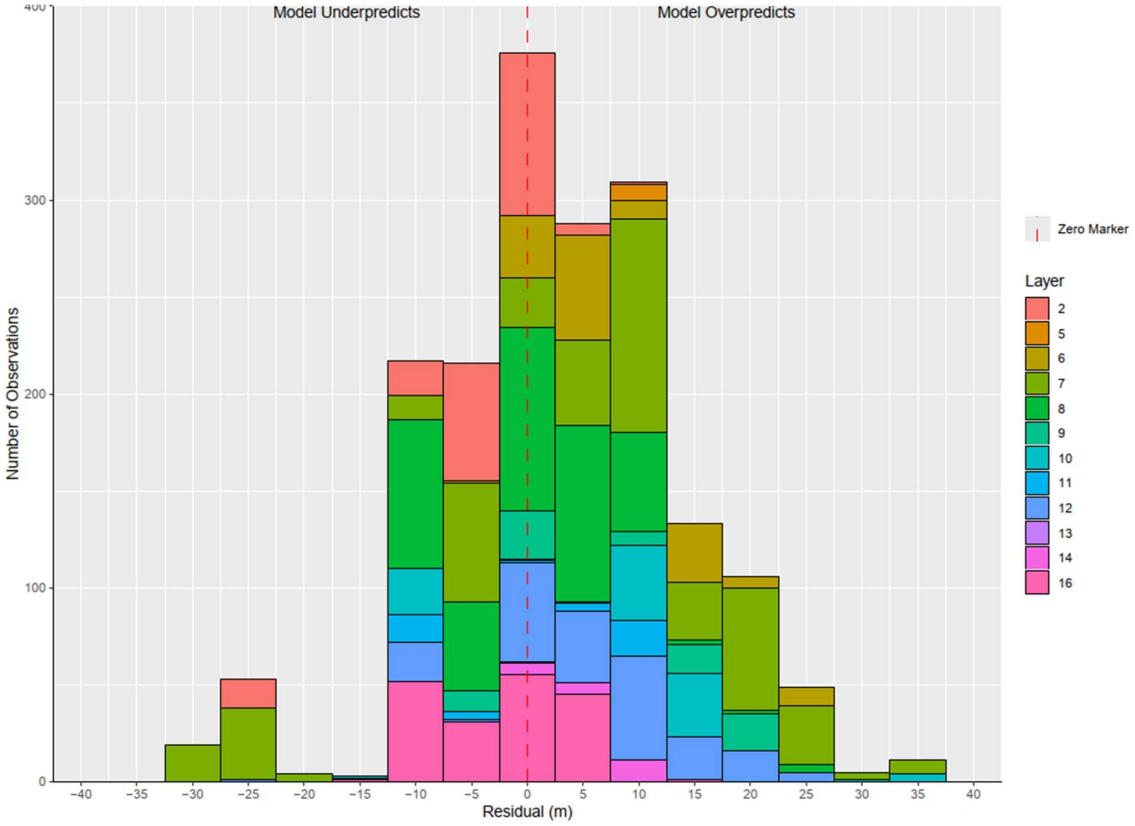


Figure 3-2 Calibration Residual Histogram

Table 3-4 shows the average calibration residual and absolute average residual per model layer, for the BCM. The residual is the difference between the measured and the modelled water level at each bore. A negative residual represents an over estimation of water levels, while a positive residual represents an underestimate.

Table 3-4 shows a general overestimation of water level in the model layers except for the Alluvium/weathered zone, some interburden and the Burngrove formation. The overestimation is greater for the Rewan Group (9.5 m on average).

Table 3-4 Average Residual by Model Layer

Model Layer*	Formation	Unit	Average Residual (m)	Average Absolute Residual (m)	Number of Observation Targets	Number of bores
2	Alluvium/ Weathered zone	Surface cover	-3.6	4.6	185	18
5	Rewan Group (Middle)	Triassic	9.8	9.8	8	1
6	Rewan Group (Lower)	Triassic	8.9	9.0	143	6
7	RCM	Overburden	5.6	13.8	447	14
8		Aries seam	1.0	6.4	367	13
9		Interburden	7.7	9.8	77	3
10		Castor seam	10.7	13.1	104	9
11		Interburden	1.9	9.1	41	3
12		Pollux seam	7.5	9.5	208	18
13		Interburden	-2.4	2.4	1	1
14		Orion seam	7.1	7.1	23	2
16	Burngrove Formation	Permian	-1.5	5.1	185	20

*There are no observation bores in Layers 1, 3, 4, 15 and 17.

The spatial distribution of average residuals for each bore from the transient calibrated model is shown in **Figure 3-3**. The size of the bore symbol in **Figure 3-3** is proportional to the residual (i.e. larger residual has a larger symbol size). **Figure 3-3** shows regionally there is a good match between the observed and simulated groundwater levels.

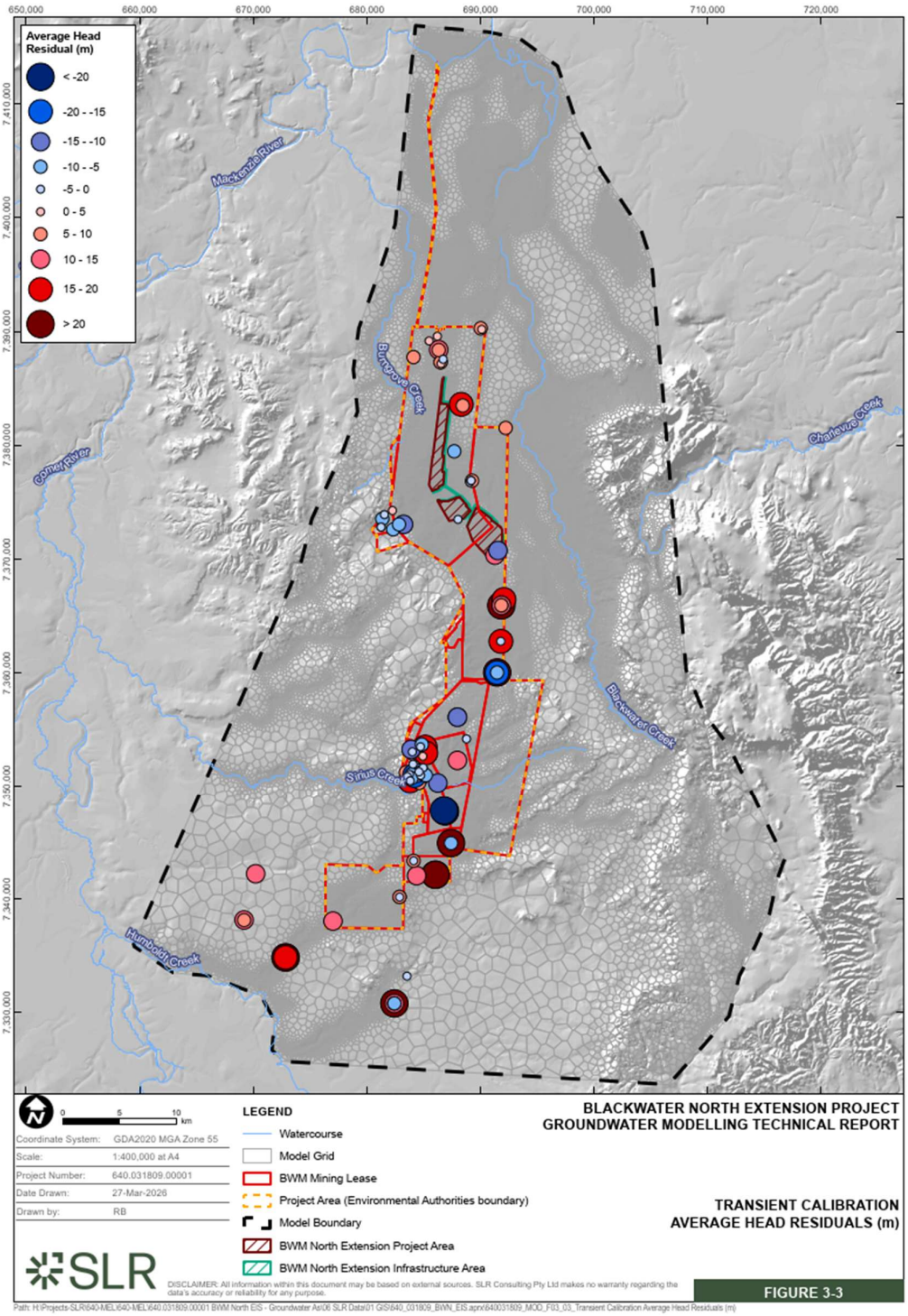


Figure 3-3 Transient Calibration Average Head Residuals (m)

3.3.2 Calibration Hydrographs

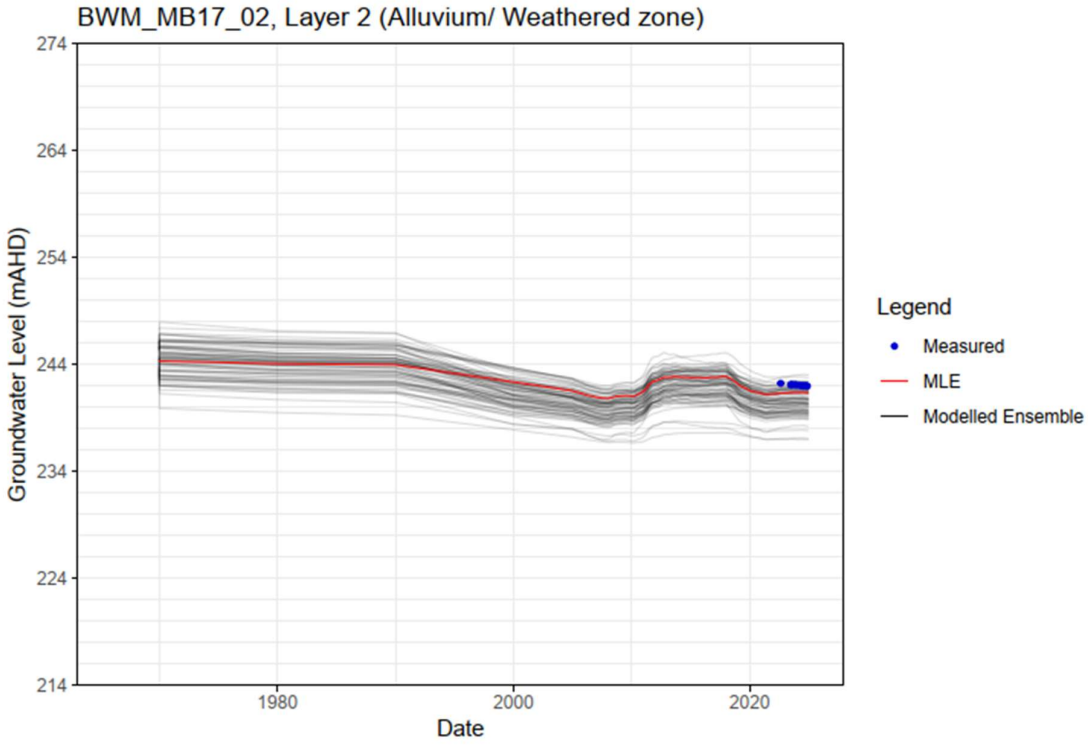
This section provides discussion on the modelled to observed groundwater level trends (calibration hydrographs) for key bores across the BWM site. Calibration hydrographs for the full calibration dataset are presented in **Appendix B**.

3.3.2.1 Alluvium and Regolith

There are no bores with valid observation data in the Alluvium and Regolith (Layer 1) in the model area.

Figure 3-4 presents the fit between simulated and observed heads in BWM_MB17_02, BWM_P4, BWM_P7 within the Alluvium and Weathered zone (Layer 2). BWM_MB17_02 is located at the edge of the South Marshmead Pit, whereas BWM_P4 and BWM_P7 are located along the western edge of the Kenmare Pit. The hydrographs for these bores generally show a close match between the simulated and measured groundwater levels.

However, as shown in the hydrographs in **Appendix B**, regionally there is a relatively good match between the simulated and measured groundwater levels in regolith bores.



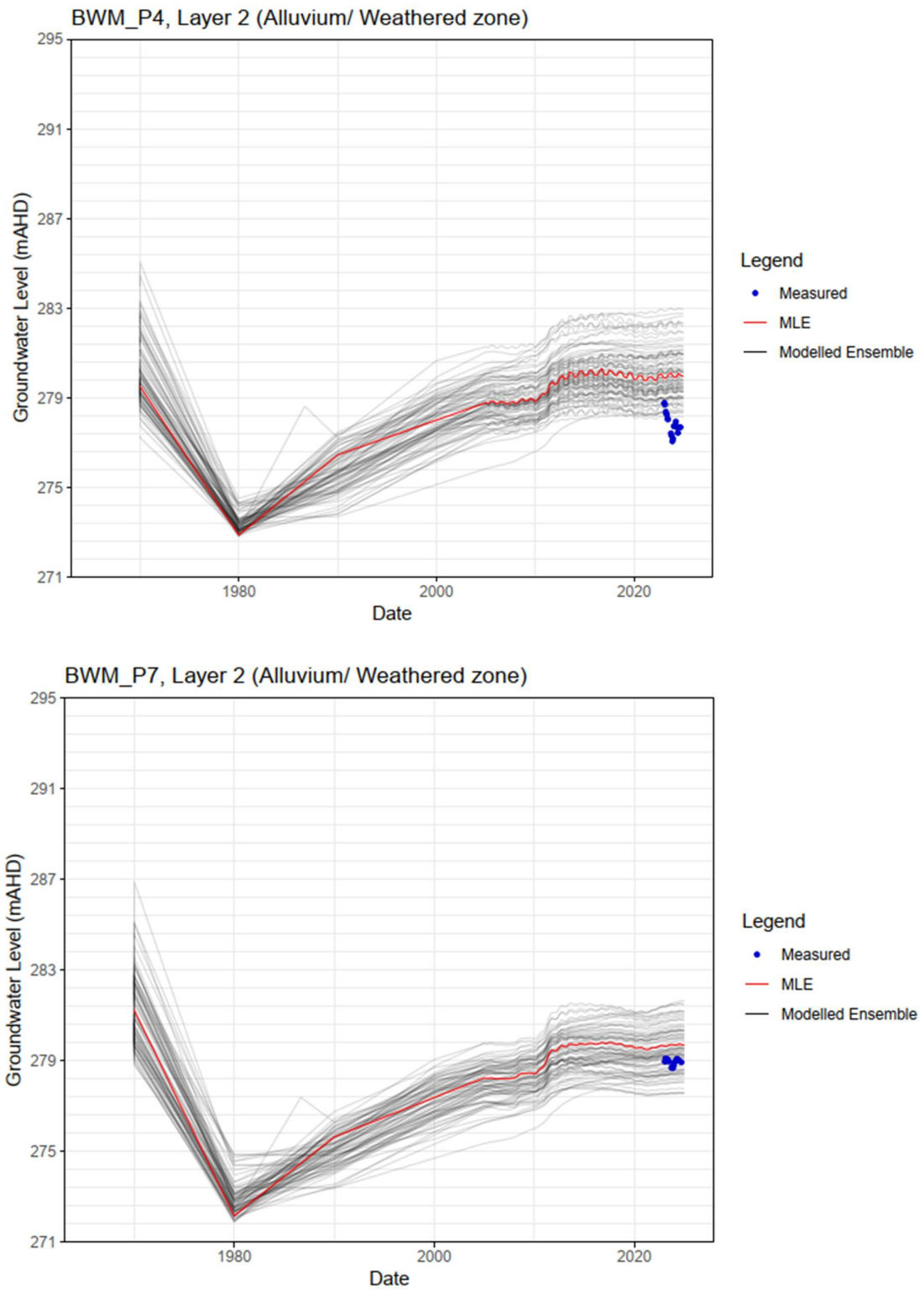
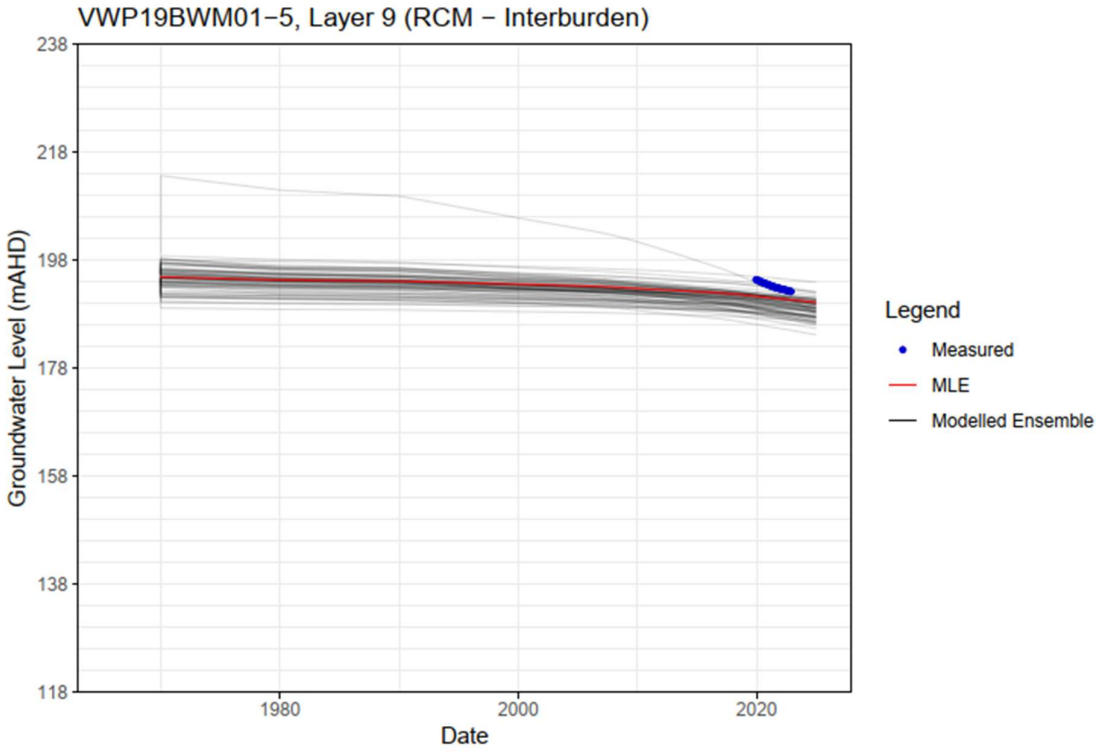


Figure 3-4 Calibration Fit - Alluvium and Regolith Bores

3.3.2.2 Interburden

The hydrographs for some of the Interburden bores are shown in **Figure 3-5** for bores VWP19BWM01-5 and VWP19BWM02-3 in the Interburden layers, located to the east of the Besgrove Pit and in the Tannyfoil Pit respectively, show that the model results in a reasonable (± 3 m) fit between modelled and observed groundwater. Trends are also relatively well reproduced.



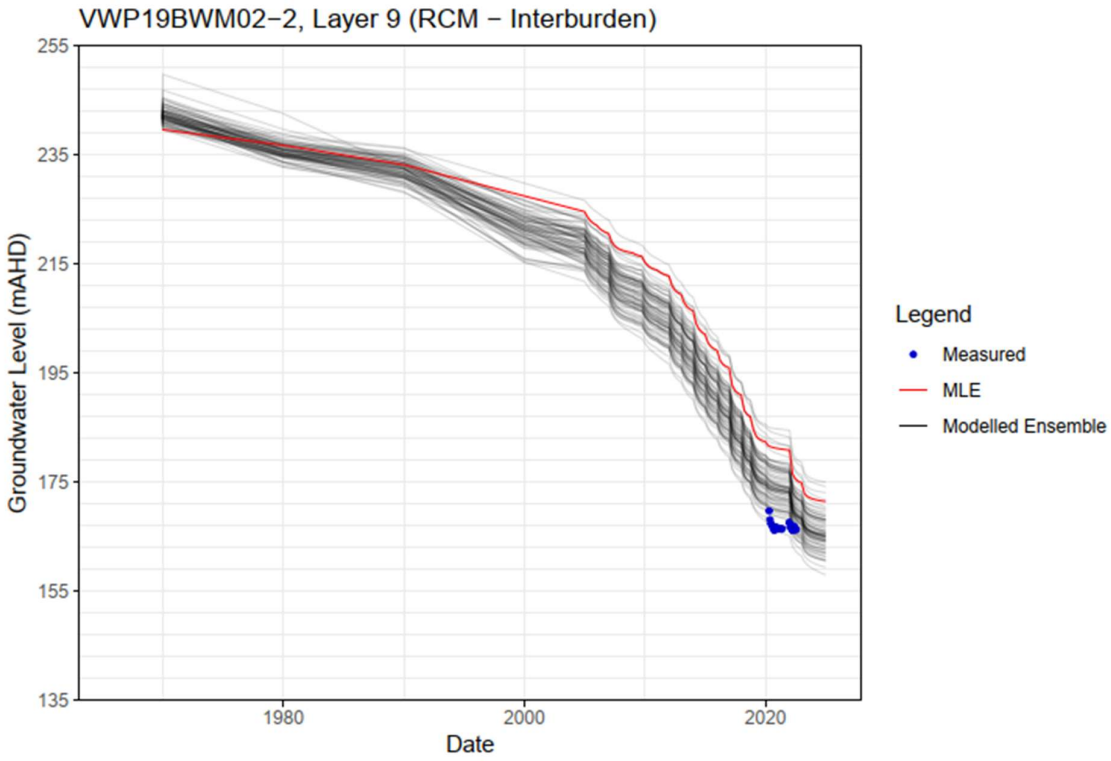


Figure 3-5 Calibration Fit - Interburden Bores

3.3.2.3 Coal Seams

The hydrographs for bores MB3, MB20BWM03P1, FY16_PZ_2 and VWP19BWM02_5 located in the Aries, Castor, Pollux and Orion seams respectively are shown in **Figure 3-6** and **Figure 3-7**. The hydrographs show that the model results in a reasonable (± 3 m) fit between modelled and observed groundwater levels for these bores. Trends are also relatively well reproduced.

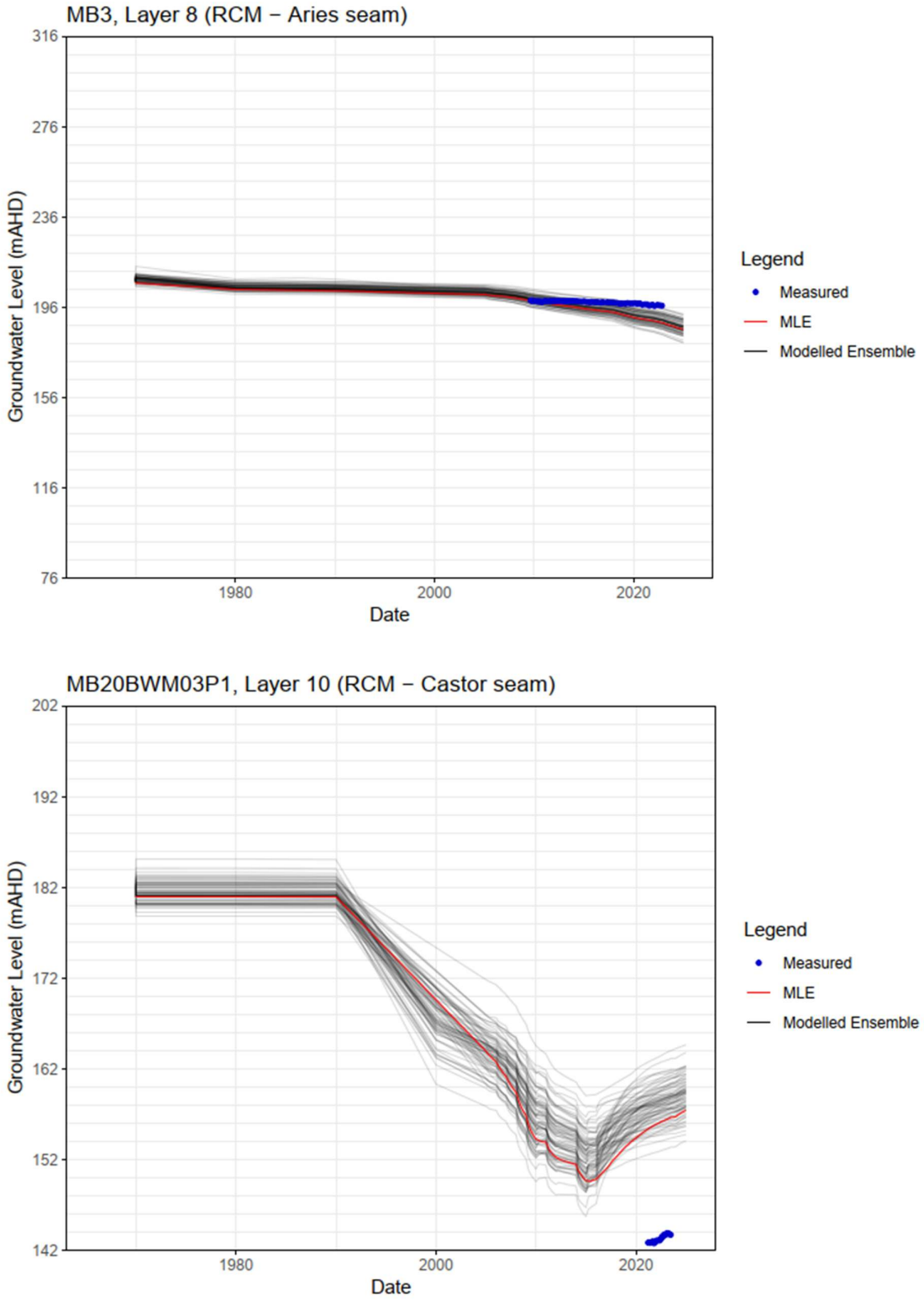


Figure 3-6 Calibration Fit – Coal Seams Bores (Aries and Castor)

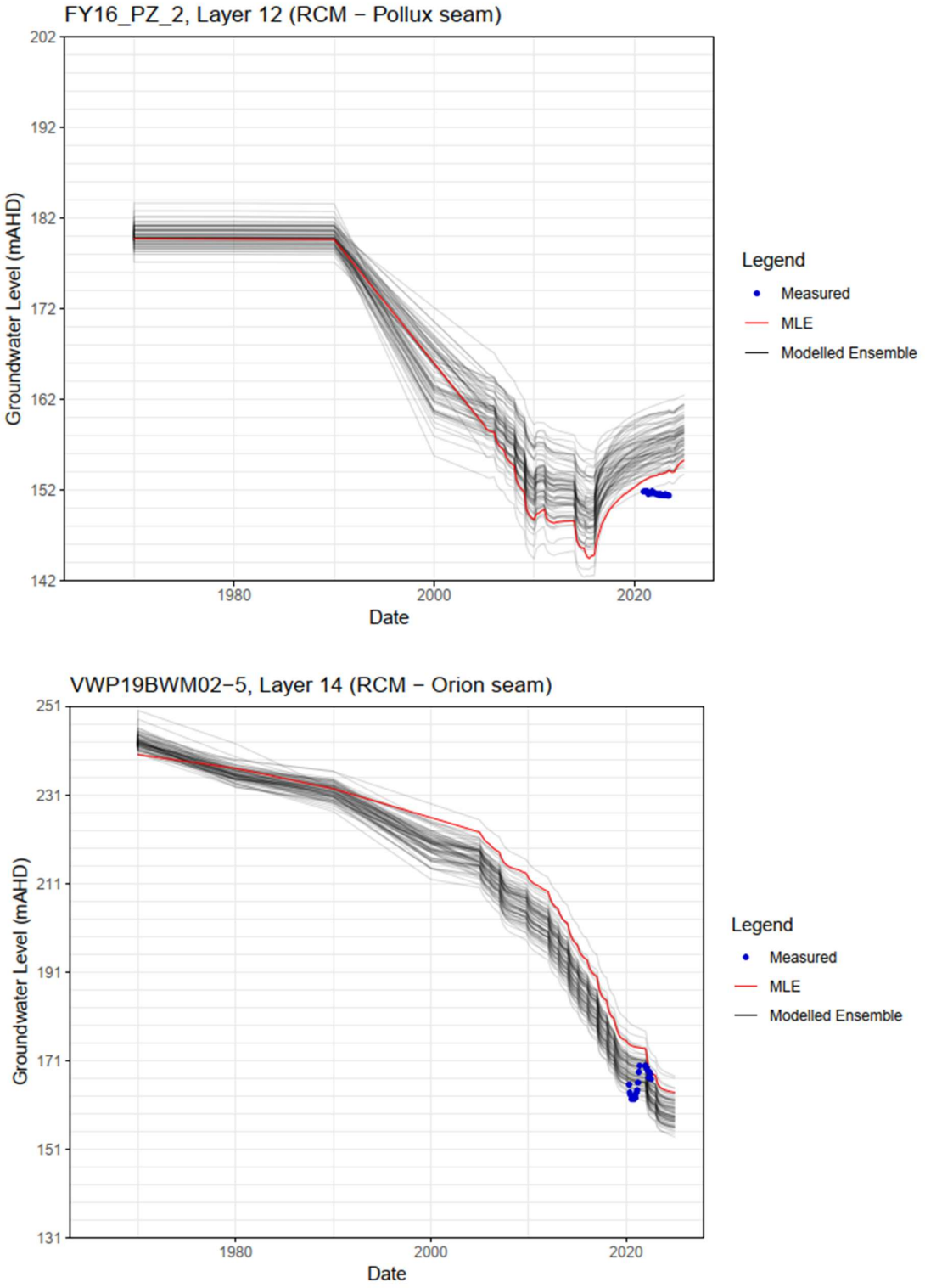


Figure 3-7 Calibration Fit – Coal Seams Bores (Pollux and Orion)

3.4 Calibration Results

3.4.1 Calibrated Fluxes

3.4.1.1 Steady State Water Balance

The water balance for the steady state model calibration is shown in **Table 3-5**. The results indicate that recharge is the dominant inflow contributor (61.8 Megalitres per day [ML/day]). ET is the highest groundwater outflow (61.6 ML/day), indicating that groundwater primarily leaves the model domain through ET. Other outflow components, such as river and GHBs, contributed only minimally. The mass balance error for the steady state calibration is 0.03%, within the error threshold recommended by the Australian Groundwater Modelling Guidelines (Barnett et al., 2012).

Table 3-5 Steady-State Model Water Balance

Component	Inflow (ML/d)	Percent of Total Inflow (%)	Outflow (ML/day)	Percent of Total Outflow (%)
Recharge (RCH)	61.8	100.0	0.0	0.0
ET (from GW) (EVT)	0.0	0.0	61.6	99.8
River (RIV)	0.0	0.0	0.0	0.0
Regional Groundwater Flow (GHB)	0.0	0.0	0.1	0.2
Mines (DRN)	0.0	0.0	0.0	0.0
Storage	0.0	0.0	0.0	0.0
Total	**61.8**	**100.0**	**61.8***	**100.0**

* Total values may not exactly equal the sum of individual components due to rounding.

3.4.1.2 Transient Water Balance

The model water balance for the transient simulation averaged over the duration of the calibration period is presented in **Table 3-6** and **Figure 3-8**.

The water balance for the transient calibration period indicates that recharge to the groundwater system within the model averages 63.8 ML/day. Approximately 56.6 ML/day is lost to ET in areas where the water table is within a few metres of the land surface.

The net flux from the GHB component is -0.4 ML/day indicating that groundwater leaves the model domain through this boundary. 10 ML/day is removed from the model by the Drain boundary condition that represents mining in the model.

The mass balance error recorded for each stress period of the transient calibration is between -0.45% and 0.08%, within the error threshold recommended by the Australian Groundwater Modelling Guidelines (Barnett et al., 2012).

Table 3-6 Transient Model Water Balance

Component	Inflow (ML/day)	Percent of Total Inflow (%)	Outflow (ML/day)	Percent of Total Outflow (%)
Recharge (RCH)	63.8	88.0	0.0	0.0
ET (from GW) (EVT)	0.0	0.0	56.6	78.1
River (RIV)	0.0	0.0	0.0	0.0
Regional Groundwater Flow (GHB)	0.2	0.3	0.6	0.8
Mines (DRN)	0.0	0.0	10.0	13.8
Storage	8.5	11.7	5.3	7.3
Total	**72.5**	**100.0**	**72.5**	**100.0**

The ET response (ET Out) to increases in recharge (Recharge In) are the largest components of outflow and inflow respectively.

Water coming out of storage (Storage In) shows peaks are associated with mine dewatering (Drains Out) peaks. Water going into storage (Storage Out) shows peaks associated with large rainfall events.

Contributions from regional boundary flow (GHB In and Out) and rivers (Riv In and Out) are small overall (**Figure 3-8**).

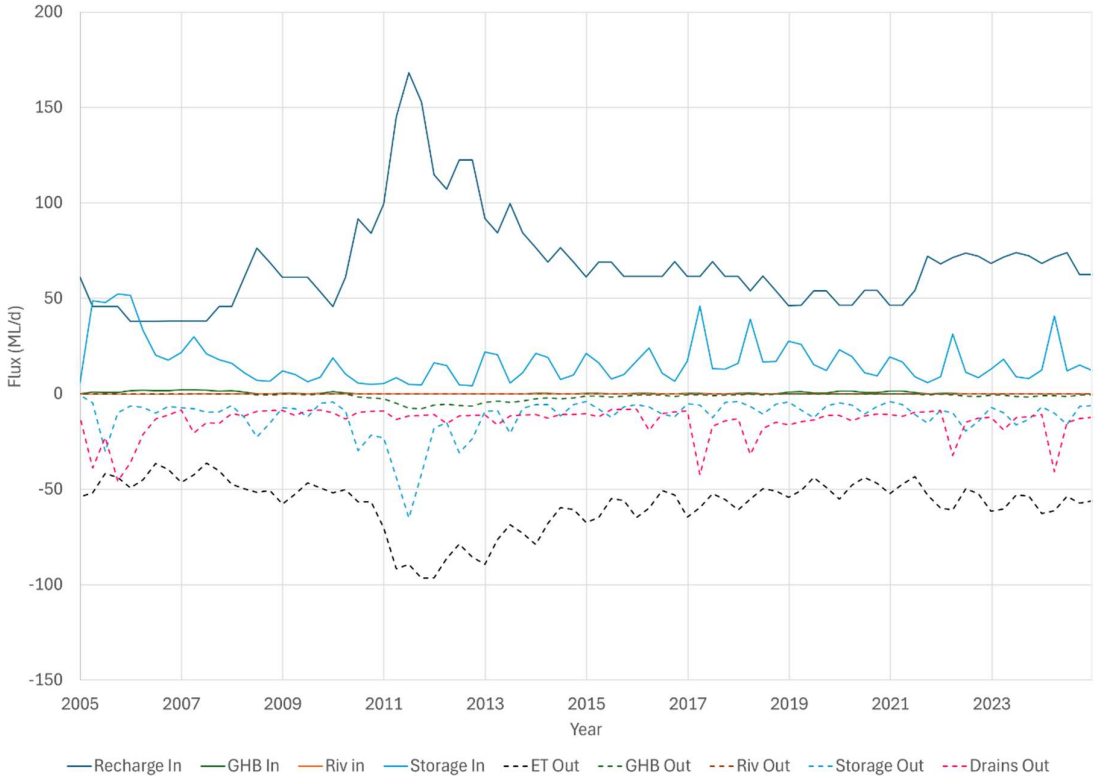


Figure 3-8 Transient Water Balance

3.4.2 Calibrated Hydraulic Parameters

3.4.2.1 Calibrated Hydraulic Conductivities

Table 3-7 provides a summary of the model layer parameter values for horizontal and vertical hydraulic conductivity.

3.4.2.1 Calibrated Storage Properties

Table 3-8 summarises the calibrated values of specific storage and specific yield for the hydrostratigraphic units.

Table 3-7 Calibrated Hydraulic Conductivity

Model Layer	Formation	Unit	Kx min (m/day)	Kx max (m/day)	Kx mean (m/day)	Kx BCM (m/day)	Kz min (m/day)	Kz max (m/day)	Kz mean (m/day)	Kz BCM (m/day)
1	Alluvium/Tertiary	Surface cover	8.7E-02	6.4E+00	1.3E+00	8.7E-02	2.2E-03	1.9E-01	3.8E-02	2.2E-03
1	Alluvium/Tertiary	Tertiary	2.1E-01	1.8E+00	8.6E-01	1.1E+00	6.7E-03	6.9E-02	2.8E-02	3.6E-02
2	Alluvium/Weathered zone	Weathered zone	9.9E-01	2.2E+01	5.6E+00	4.7E+00	1.8E-02	7.5E-01	1.6E-01	7.9E-02
2	Alluvium/Weathered zone	Regolith	3.7E-01	2.1E+00	1.3E+00	8.8E-01	9.0E-03	6.7E-02	3.5E-02	2.5E-02
3	Clematis Group	Triassic	4.2E-02	1.7E+00	6.2E-01	1.4E+00	3.5E-03	2.0E-01	3.9E-02	1.0E-01
4	Rewan Group (Upper)	Triassic	9.0E-04	1.3E+00	1.7E-01	4.7E-02	2.4E-05	6.2E-01	2.2E-02	3.8E-04
5	Rewan Group (Middle)	Triassic	2.5E-05	4.4E-02	9.2E-03	1.4E-03	6.6E-07	1.3E-02	1.2E-03	3.9E-05
6	Rewan Group (Lower)	Triassic	2.1E-05	1.1E-01	1.3E-02	1.2E-02	6.0E-07	1.2E-02	2.0E-03	8.3E-04
7	RCM	Overburden	1.3E-04	1.3E-02	2.0E-03	1.6E-03	1.0E-05	1.8E-03	1.1E-04	1.3E-04
8		Aries seam	2.3E-05	3.4E-04	6.1E-05	2.3E-05	1.7E-07	1.3E-06	4.0E-07	6.6E-07
9		Interburden	9.6E-04	1.5E-02	6.0E-03	1.4E-02	5.5E-05	1.2E-02	5.9E-04	1.5E-04
10		Castor seam	7.5E-05	8.6E-02	7.9E-03	2.2E-02	9.5E-07	5.0E-03	5.0E-04	4.0E-04
11		Interburden	4.2E-04	3.6E-02	6.6E-03	3.8E-03	5.0E-06	1.6E-04	3.4E-05	1.4E-05
12		Pollux seam	5.0E-05	2.6E-02	3.8E-03	7.7E-04	3.5E-06	6.0E-03	5.4E-04	2.2E-04
13		Interburden	1.6E-04	2.4E-02	5.0E-03	1.1E-03	1.5E-05	4.5E-03	6.0E-04	1.7E-04
14		Orion seam	3.1E-05	2.8E-01	2.3E-02	2.8E-01	2.7E-06	2.0E-01	1.0E-02	2.0E-01
15		Underburden	1.6E-05	1.1E-02	1.0E-03	4.0E-04	4.3E-08	1.6E-03	1.3E-04	1.1E-04
16	Burngrove Formation	Permian	2.4E-05	6.8E-03	8.8E-04	5.0E-05	2.4E-05	1.3E-03	1.6E-04	4.1E-05
17	Basement	Permian and/or below	1.2E-05	1.9E-03	5.0E-04	3.1E-04	3.6E-07	1.2E-03	5.2E-05	4.3E-06



Table 3-8 Calibrated Storage Parameters

Model Layer	Formation	Unit	Sy min (-)	Sy max (-)	Sy mean (-)	Sy BCM (m/day)	Ss min (m^{-1})	Ss max (m^{-1}))	Ss mean (m^{-1})	Ss BCM (m^{-1})
1	Alluvium/Tertiary	Surface cover	3.5E-02	7.2E-02	4.9E-02	5.0E-02	5.0E-07	2.7E-05	4.7E-06	5.8E-06
1	Alluvium/Tertiary	Tertiary	2.5E-02	4.0E-02	3.2E-02	2.8E-02	5.9E-07	3.7E-05	8.4E-06	3.0E-06
2	Alluvium/Weathered zone	Weathered zone Regolith	2.8E-02	6.7E-02	4.8E-02	4.0E-02	8.0E-07	4.6E-05	1.3E-05	5.5E-06
2	Alluvium/Weathered zone	Regolith	2.8E-02	4.2E-02	3.5E-02	3.6E-02	5.0E-07	1.4E-05	3.4E-06	1.7E-06
3	Clematis Group	Triassic	2.7E-03	5.3E-03	3.9E-03	3.4E-03	1.0E-07	2.1E-06	4.9E-07	8.4E-07
4	Rewan Group (Upper)	Triassic	1.4E-03	2.6E-02	8.5E-03	8.9E-03	1.3E-07	3.6E-06	1.0E-06	2.8E-07
5	Rewan Group (Middle)	Triassic	1.7E-03	2.4E-02	8.1E-03	3.9E-03	1.0E-07	2.5E-06	6.9E-07	4.6E-07
6	Rewan Group (Lower)	Triassic	3.0E-03	3.0E-02	1.4E-02	2.7E-02	1.3E-07	3.9E-06	9.4E-07	6.1E-07
7	RCM	Overburden	1.3E-03	1.5E-02	5.2E-03	2.9E-03	1.9E-07	4.5E-06	1.4E-06	1.7E-06
8		Aries seam	1.1E-03	2.4E-02	7.6E-03	4.2E-03	1.0E-07	3.2E-06	6.8E-07	2.1E-07
9		Interburden	2.1E-03	3.0E-02	1.1E-02	6.9E-03	2.2E-07	5.0E-06	2.1E-06	2.8E-06
10		Castor seam	1.1E-03	2.7E-02	5.8E-03	2.2E-03	2.3E-07	5.0E-06	1.5E-06	2.0E-06
11		Interburden	2.6E-03	3.0E-02	1.1E-02	4.7E-03	1.2E-07	3.1E-06	6.3E-07	1.4E-07
12		Pollux seam	1.1E-03	1.6E-02	5.9E-03	8.2E-03	1.5E-07	4.5E-06	8.0E-07	5.2E-07
13		Interburden	1.1E-03	2.3E-02	5.6E-03	2.9E-03	1.9E-07	5.0E-06	1.1E-06	5.7E-07
14		Orion seam	1.3E-03	2.3E-02	7.1E-03	2.7E-03	1.2E-07	4.5E-06	9.5E-07	1.1E-06
15		Underburden	1.1E-03	1.7E-02	6.0E-03	1.7E-02	1.1E-07	3.1E-06	8.2E-07	1.3E-06
16	Burngrove Formation	Permian	1.1E-03	2.2E-02	6.7E-03	8.0E-03	1.0E-07	2.2E-06	4.4E-07	2.7E-07
17	Basement	Permian and/or below	1.7E-03	2.8E-02	9.9E-03	1.4E-02	1.0E-07	1.2E-06	3.9E-07	3.6E-07



3.4.3 Calibrated Boundary Conditions

3.4.3.1 Calibrated Recharge

Table 3-9 presents the calibrated recharge rates for each zone in the model. The mean annual rainfall was assumed to be 546 millimetres per year (mm/year), based on SILO gridded data. This value was used to convert deep drainage to an equivalent annual rainfall.

Table 3-9 Calibrated Rainfall Recharge

Model Recharge Zone	Percentage of Rainfall (%)				Long-term Average Rainfall Recharge (mm/year)			
	Min	Max	Mean	BCM	Min	Max	Mean	BCM
Alluvium Quaternary	0.1	0.9	0.3	0.2	0.6	5.2	1.8	1.1
Regolith	0.0	0.3	0.1	0.1	0.1	1.7	0.4	0.4
Weathered Clematis	0.2	4.2	1.3	1.1	1.0	23.1	7.1	6.0
Weathered Permian	1.5	5.1	3.8	4.0	8.1	28.1	20.7	21.9
Spoil	1.0	5.4	2.8	3.0	5.6	29.7	15.3	16.1
Tailing	0.0	2.5	0.4	0.2	0.1	13.8	2.0	1.1

3.4.3.2 Calibrated Evapotranspiration

Table 3-10 presents the calibrated EVT rates and extinction depth. The mean annual potential ET was assumed to be 1,644 mm/year, based on SILO gridded data. This value was applied to the steady-state and predictive periods, while a time-varying series was applied during the transient calibration period.



Table 3-10 Calibrated Evapotranspiration Rate and Extinction Depth Bounds

Model EVT Zone	EVT factor of PAN				EVT Depth (m)				Long-term Potential EVT (mm/year)	Long-term Average EVT (mm/year)			
	Min	Max	Mean	BCM	Min	Max	Mean	BCM		Min	Max	Mean	BCM
Alluvium Quaternary	0.5	0.9	0.7	0.6	1.7	13.7	6.6	5.0	1644.0	845.6	1543.9	1105.2	1041.6
Regolith	0.5	0.9	0.7	0.8	0.7	11.2	3.3	4.5		897.6	1557.7	1198.5	1361.8
Weathered Clematis	0.5	0.8	0.7	0.6	0.6	12.5	3.6	4.3		822.7	1372.4	1077.7	1044.1
Weathered Permian	0.5	0.8	0.6	0.6	6.6	14.9	11.5	12.7		821.3	1350.1	1028.7	1025.5
Spoil	0.5	0.9	0.6	0.5	0.5	2.5	1.2	1.3		821.3	1404.9	1056.4	821.3
Tailing	0.5	0.9	0.7	0.6	0.5	2.9	1.2	1.2		838.2	1471.0	1102.5	903.4



3.4.3.3 Calibrated River Boundary

Calibrated river vertical conductivity are presented in **Table 3-11** and calibrated tailing deposition vertical conductivity are presented in **Table 3-12**.

Table 3-11 Calibrated River Vertical Conductivity

Zone	Vertical K (m/day)				River Name
	Min	Max	Mean	BCM	
1	1.2E-05	1.6E-01	1.5E-02	8.9E-03	Blackwater mainstream
2	8.5E-04	1.0E+00	3.6E-01	2.1E-01	Blackwater tributaries
3	1.0E-05	1.9E-01	7.7E-03	3.7E-03	Sirius Creek
4	5.3E-05	5.6E-01	3.2E-02	2.7E-03	Rockland Creek and tributaries
5	2.1E-05	7.9E-01	3.8E-02	1.5E-02	Humboldt Creek and tributaries
6	9.0E-05	7.4E-01	8.3E-02	2.5E-02	Planet Creek and tributaries
7	1.0E-05	2.8E-01	1.5E-02	3.8E-05	Small streams
8	1.1E-05	1.5E-01	7.3E-03	7.4E-05	Deep Creek dam
9	1.0E-05	6.7E-02	4.2E-03	8.8E-04	New Taurus dam
10	3.7E-05	6.2E-01	3.8E-02	1.7E-04	Tannyfoil dam

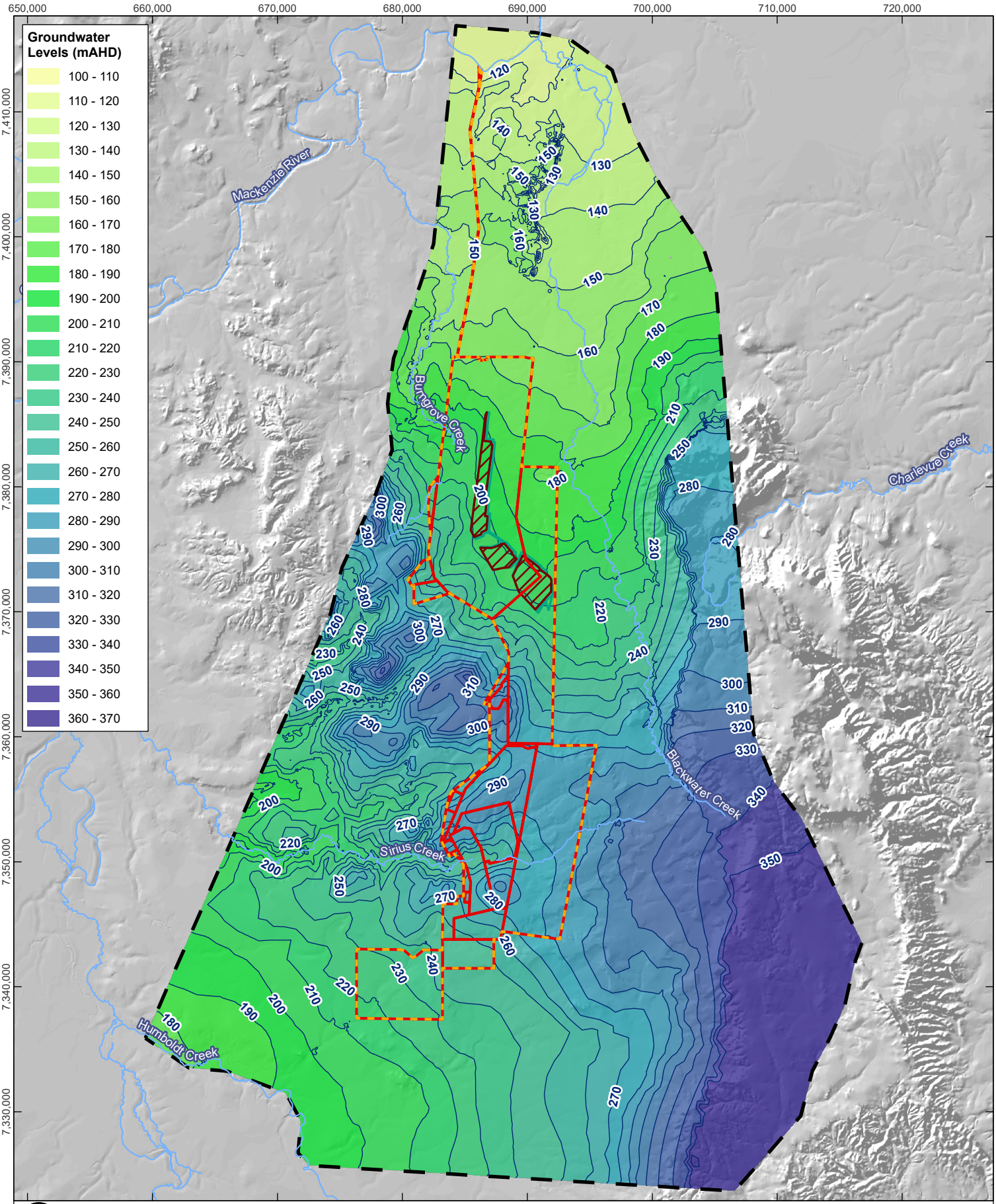
Table 3-12 Calibrated Tailing Deposition Vertical Conductivity

Tailings	Kz (m/day)				Stage
	Min	Max	Mean	BCM	
BD-R10N	2.7E-06	9.5E-05	2.5E-05	4.9E-05	Deposited from July 2023 until 2040
BD-R12N	2.7E-06	9.5E-05	2.5E-05	4.9E-05	Deposited from July 2023 until 2040
BD-R12S	2.7E-06	9.5E-05	2.5E-05	4.9E-05	Deposited from July 2023 until 2040
R74	2.7E-06	9.5E-05	2.5E-05	4.9E-05	Deposited from Oct 2015 until 2023
Curragh Mine	2.7E-06	9.5E-05	2.5E-05	4.9E-05	Deposited from Jan 2007 until 2023

3.4.4 Calibrated Water Table Elevation

The calibrated water table elevation is presented for steady state period (**Figure 3-9**) and the end of the calibration period (**Figure 3-10**).





0 5 10 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:400,000 at A4
Project Number:	640.031809.00001
Date Drawn:	16-Feb-2026
Drawn by:	RB

LEGEND

- Watercourse
- Groundwater Level Contour (10mAHD)
- BWM Mining Lease
- Project Area (Environmental Authorities boundary)
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

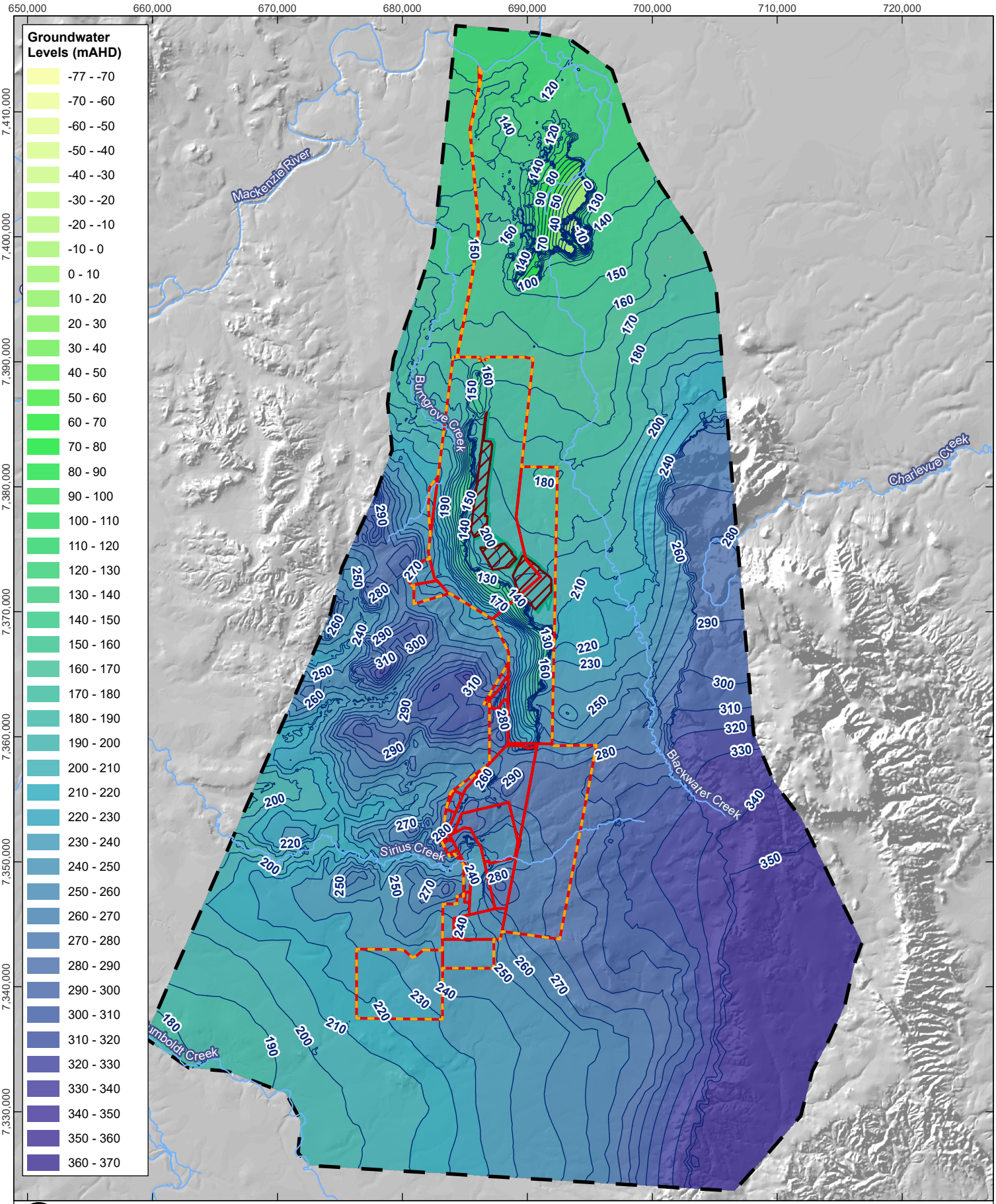
CALIBRATED WATER TABLE ELEVATION, STEADY STATE

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE 3-9

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F03_09_Calibrated Water Table Elevation - Steady State Period



0 5 10 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:400,000 at A4
Project Number:	640.031809.00001
Date Drawn:	16-Feb-2026
Drawn by:	RB

LEGEND

- Watercourse
- Groundwater Level Contour (10mAHD)
- BWM Mining Lease
- Project Area (Environmental Authorities boundary)
- Model Boundary
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

CALIBRATED WATER TABLE ELEVATION - END OF CALIBRATION

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE 3-10

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F03_10_Calibrated Water Table Elevation - End of Calibration

4.0 Predictive Modelling – Mining Period

4.1 Timing and Mining

Transient predictive modelling was used to simulate the proposed mining at the Project as well as mining at other approved and foreseeable mines within the model domain. The cumulative assessment was undertaken for BWM (northern portion), the Project (SA 7 and SA 10), BWM (southern portion), Curragh Mine (operating mine), and Cook Collieries. The simulated predictive mine progression for BWM, including the Project, is presented in **Figure 4-1**.

The predictive part of the model comprises annual stress periods, commencing January 2025 through until December 2093. The predictive model stress period setup is detailed in **Appendix C** alongside simulated mine timings.

Transient predictive models have been developed for three scenarios:

- Cumulative Scenario– all approved and foreseeable mining in the model area and at BWM plus the Project.
- Approved Scenario– all approved and foreseeable mining in in the model area and at BWM without the Project.
- Null Run – no mining within the model area.

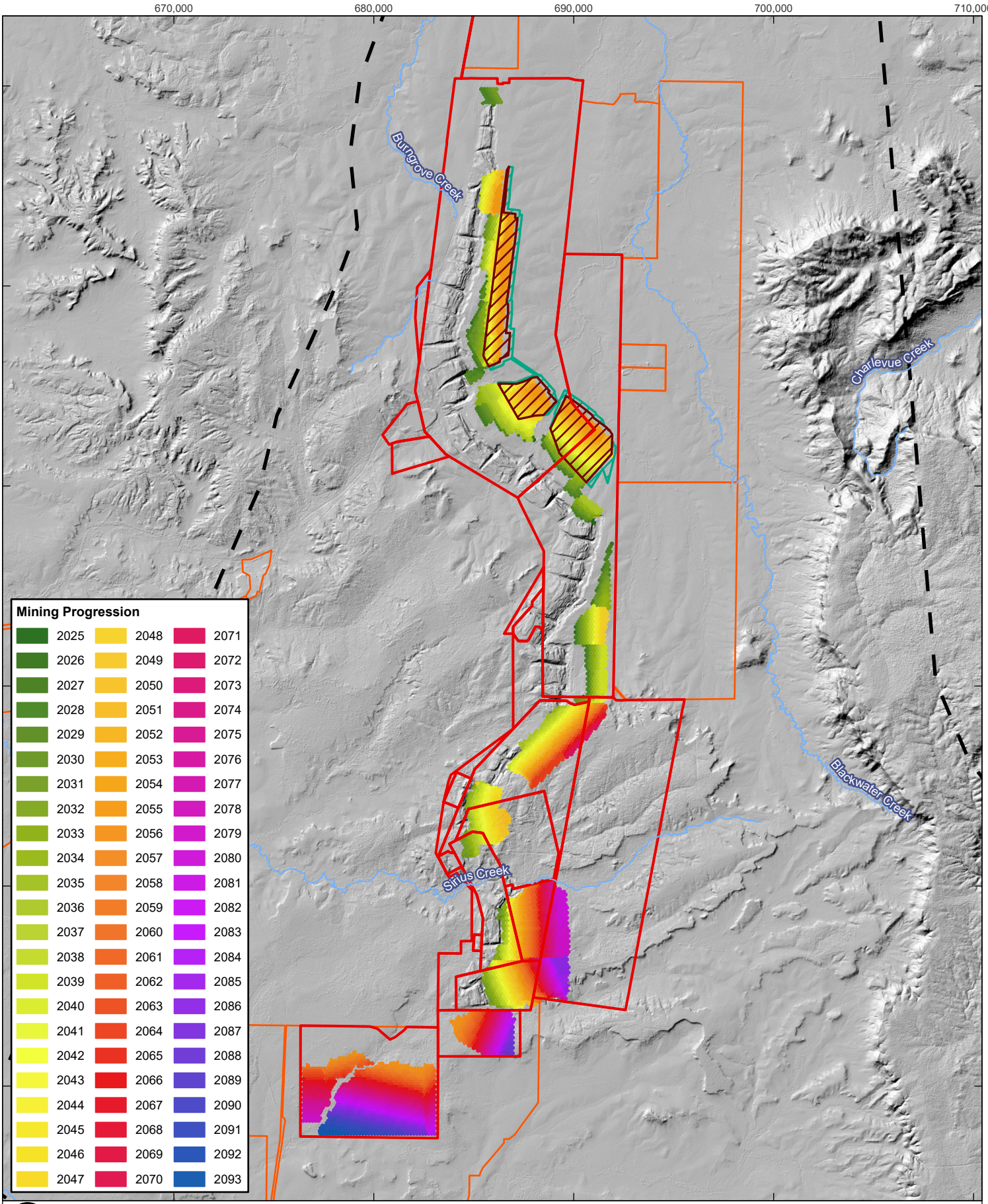
The Project effects (i.e. the incremental changes) are estimated by the difference between the Cumulative and Approved scenarios. Mining cells progressed annually and drain cells simulating the mining were projected down to the base of the lowermost target coal seam (i.e. the Pollux seam).

To define the active drainage period for the mining cells at the project, rather than assuming a fixed period of 1 or 2 years, an in-house script that dynamically calculates this period by referencing adjacent mining cells was utilised. For each cell, the script identifies the nearest mined neighbour in the same pit and compares their mining time. The difference determines how long the cell should be draining, providing a more realistic and spatially responsive representation of pit dewatering. After the drains were removed the TVM package was used to assign spoil/void/tailing properties to the cells depending on their spatial location.

Appendix C presents the simulated mine timings for the Project and surrounding mines used in the predictive model. BWM (including the Project) was included for the predictive run, as all other mines have either been in closure or care and maintenance or the future mining sequence was not available. The cumulative impact assessment however will consider those mines as they were included in the calibration period up to end of 2024. The following applies:

- Cook Colliery underground mining: in closure, active during calibration period and included as such.
- Curragh mine: Coronado currently operates the Curragh coal mine complex, which is located adjacent to the Project and approximately 8 km north of Blackwater Township. The complex comprises two open cut mines (Curragh North and Curragh South) and an underground mine (Mammoth Underground). The open cut operations began in 1983, extracting coal from the Aries, Pisces, Castor and Pollux coal seams of the RCM, while the underground mine started in 2024.

All mines included in the model were simulated using the DRN package. A nominally high drain conductance of 100 square metres per day (m²/day) was applied to drain cells to simulate rapid removal of water from the system.



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	16-Feb-2026
Drawn by:	AS

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Study Area
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

PROJECT INDICATIVE MINE PROGRESSION

SLR

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FIGURE 4-1

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F04_01_Project Indicative Mine Progression

4.2 Water Balance

Table 4-1 to **Table 4-3** provide average flow rates (January 2025 until December 2093) for water transfer into and out of the groundwater model domain for the three predictive scenarios; the Cumulative, Approved and Null Run. The cumulative mass balance error over the entire simulation period is < 0.1% for all three scenarios.

The tables show that simulated recharge increased from 61.8 ML/day in the Null scenario to 64.5 ML/day and 62.7 ML/day in the Cumulative scenario and the Approved scenario respectively. The increase in recharge is due to the presence of open cut mining and enhanced recharge through the spoil to the groundwater system in the Approved and Cumulative scenarios.

Table 4-1 to **Table 4-3** and **Figure 4-2** to **Figure 4-4** show that in all three predictive scenarios, groundwater leaves the model through regional groundwater flow (GHB). The GHB inflow and outflow are < 0.4% of the total inflow and outflow in water balance for all the scenarios indicating the model boundary conditions do not have a significant influence on the model predictions.

ET decreased from 56.6 ML/day in the Null Scenario to 51.4 ML/day and 51.7 ML/day in the Project and Approved scenarios. The ET decline is primarily due to the mining activities and decline of water levels within the saturated shallow areas such as voids, pits or outcropping areas.

The net groundwater flow to Blackwater Creek is 0.02 ML/day in all three scenarios. All scenarios indicate the flow is generally from groundwater to the Creek, however this flow is very minor (and shows that Blackwater Creek does not receive continuous amounts of baseflow).

Groundwater outflow from the model occurs predominantly via drain cells, used to simulate open cut and underground mining activity in the model. **Table 4-1** and **Table 4-2** show that the Cumulative scenario resulted in an increase in the average drain outflow (to 14.5 ML/day from 11.8 ML/day predicted for the Approved scenario). The storage component in the table refers to changes in the water level over the transient simulation timeframe. Changes in the storage between the Approved and Cumulative Scenarios relate to the change in mine footprint and added recharge through spoil.

Table 4-1 Average Simulated Water Balance over the Predictive Period - Cumulative

Component	Inflow (ML/day)	Percent of Total Inflow (%)	Outflow (ML/day)	Percent of Total outflow (%)
Recharge (RCH)	64.5	75.4	0.0	0.0
ET (from GW) (EVT)	0.0	0.0	51.4	60.0
Surface Drainages (RIV)	0.0	0.0	0.0	0.0
Pit Lakes and dams (CHD)	6.9	8.1	5.2	6.1
Regional Groundwater Flow (GHB)	0.3	0.4	0.1	0.2
Mines (DRN)	0.0	0.0	14.5	16.9
Storage	13.8	16.1	14.3	16.8
Total	**85.5**	**100.0**	**85.6**	**100.0**

Table 4-2 Average Simulated Water Balance over the Predictive Period – Approved

Component	Inflow (ML/day)	Percent of Total Inflow (%)	Outflow (ML/day)	Percent of Total outflow (%)
Recharge (RCH)	62.7	77.2	0.0	0.0
ET (from GW) (EVT)	0.0	0.0	51.7	63.6
Surface Drainages (RIV)	0.0	0.0	0.0	0.0
Pit Lakes and dams (CHD)	6.0	7.5	7.9	9.8
Regional Groundwater Flow (GHB)	0.3	0.4	0.1	0.2
Mines (DRN)	0.0	0.0	11.8	14.5
Storage	12.2	15.0	9.6	11.9
Total	**81.2**	**100.0**	**81.2**	**100.0**

Table 4-3 Average Simulated Water Balance over the Predictive Period - Null Run

Component	Inflow (ML/day)	Percent of Total Inflow (%)	Outflow (ML/day)	Percent of Total outflow (%)
Recharge (RCH)	61.8	99.6	0.0	0.0
ET (from GW) (EVT)	0.0	0.0	61.8	99.7
Surface Drainages (RIV)	0.0	0.0	0.0	0.0
Pit Lakes and dams (CHD)	0.0	0.0	0.0	0.0
Regional Groundwater Flow (GHB)	0.0	0.0	0.2	0.2
Mines (DRN)	0.0	0.0	0.0	0.0
Storage	0.2	0.4	0.0	0.0
Total	**62.0**	**100.0**	**62.0**	**100.0**



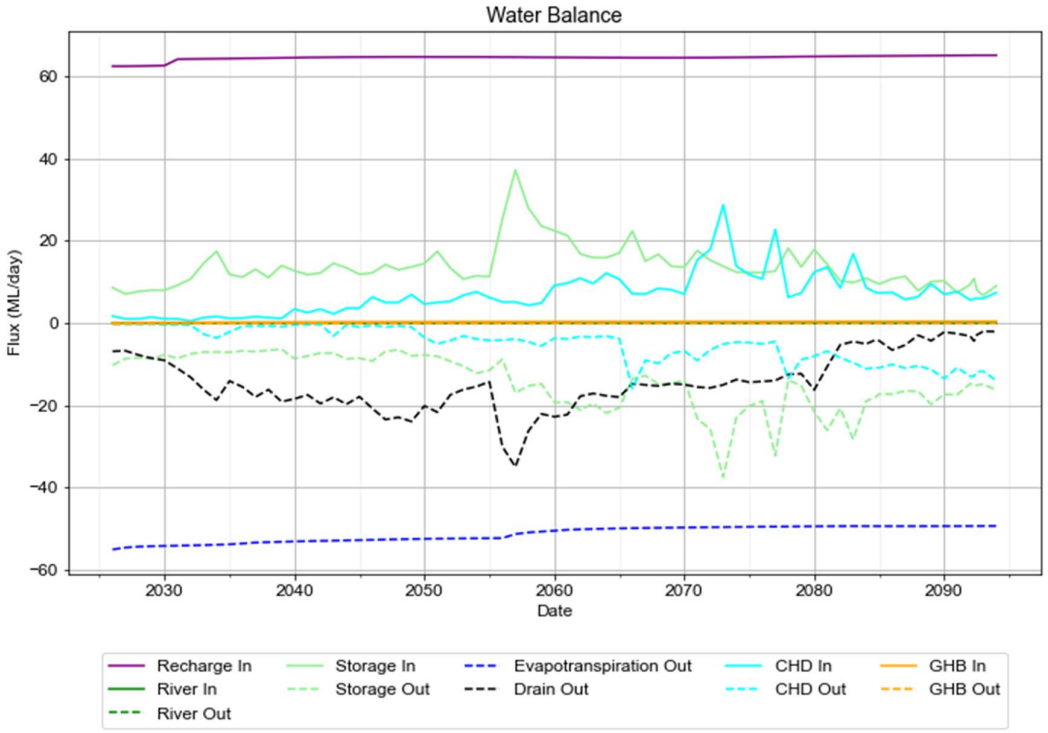


Figure 4-2 Transient Water Balance Over the Prediction Period – Cumulative

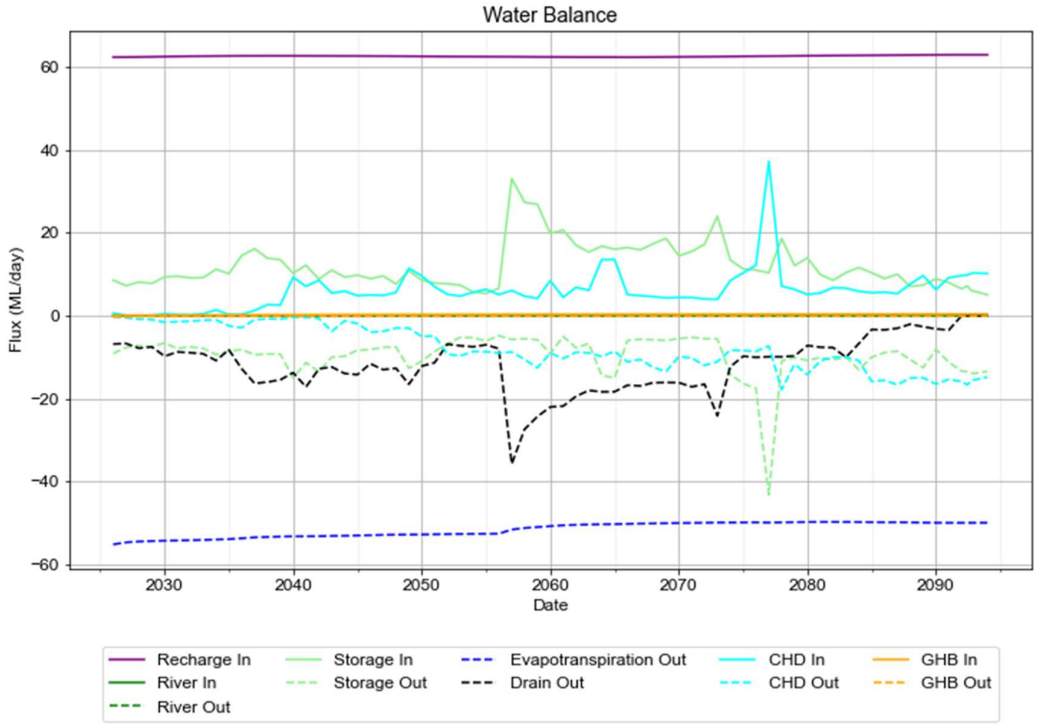


Figure 4-3 Transient Water Balance Over the Prediction Period - Approved

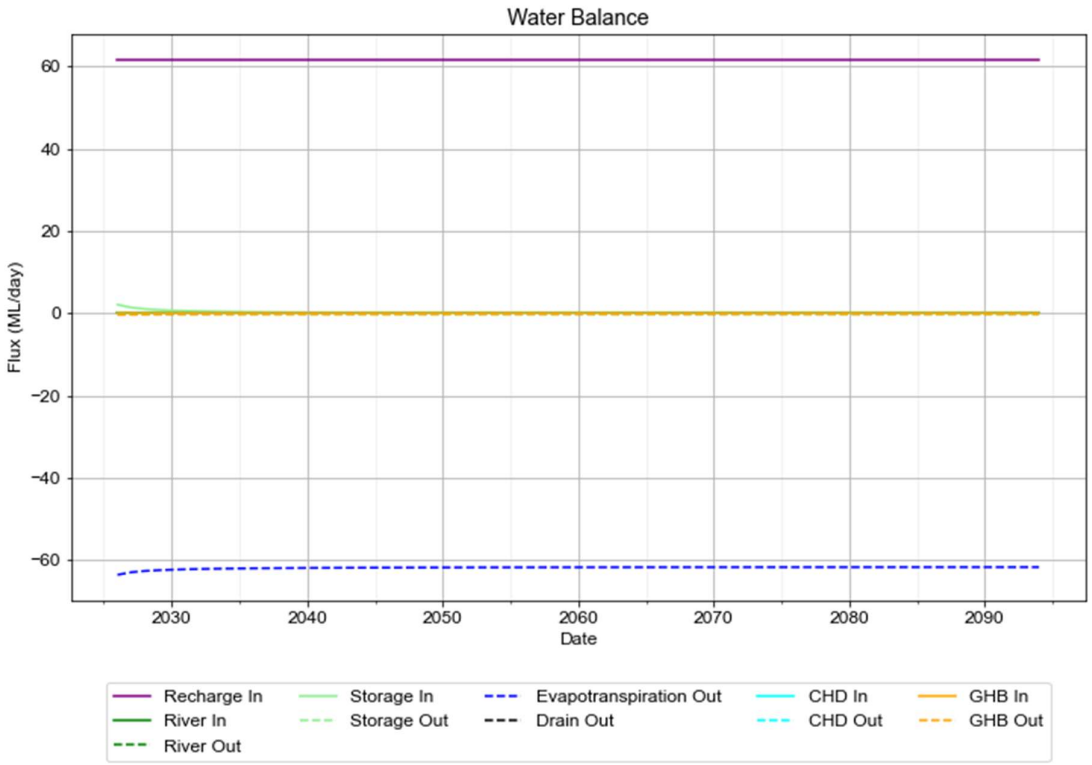


Figure 4-4 Transient Water Balance Over the Prediction Period – Null Run

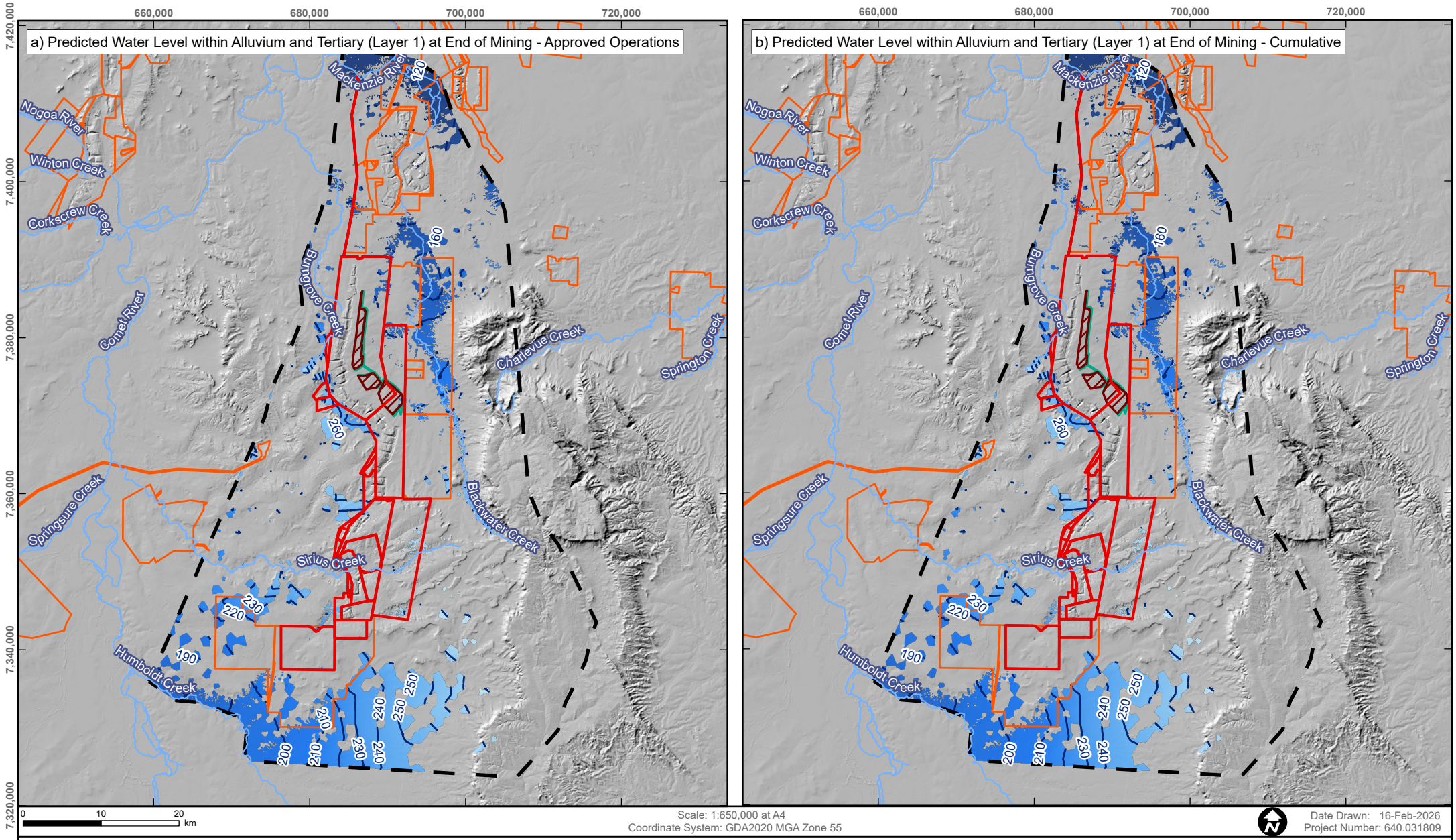
4.3 Predicted Groundwater Levels

Predicted groundwater levels at the end of the modelling timeframe for the Approved and Cumulative scenarios are provided in **Figure 4-5** to **Figure 4-8**. In these four figures, the Approved scenario is presented on the left side, and the Cumulative scenario is presented on the right side. The grey cells in the water level grids represent unsaturated areas (i.e., where the simulated water level elevation is below the base of cell) or an area where the layer is not present.

Minimal changes to alluvium/tertiary (Layer 1) groundwater levels are observed between the Approved and Cumulative mining scenarios (**Figure 4-5**). **Figure 4-6** shows that the dewatering of the weathered zone (Layer 2) caused by the Project occurs particularly within the area immediately to the east of the Project area. **Figure 4-6** also shows that there are no significant changes to the water levels along Blackwater Creek between the Approved and Cumulative Scenarios.

Figure 4-7 shows the predicted groundwater levels in the Clematis sandstone (Layer 3). The Clematis Sandstone is presenting as an outcrop at the eastern side of the model and is disconnected from the Permian coal measures by the Rewan formation. **Figure 4-7** also shows that there are no significant changes to the water levels between the Approved and Cumulative scenarios, indicating that the Clematis sandstone would not be impacted by the Project.

Figure 4-8 show the predicted water levels in the Permian coal measures (Layer 12) at the end of mining for the Approved and Cumulative mining scenarios. **Figure 4-8** shows that the groundwater flow is generally from southeast and south towards Blackwater Creek in the centre and north of the model. Zones of depressurisation at the Project and surrounding mines are shown to cause localised interruptions to the regional flow gradient.



Scale: 1:650,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 16-Feb-2026
Project Number: 640.031809

SLR

Service Layer Credits:

Credits:

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LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Study Area
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area
- Groundwater Contour (mAHD)

Groundwater Level (mAHD)

332

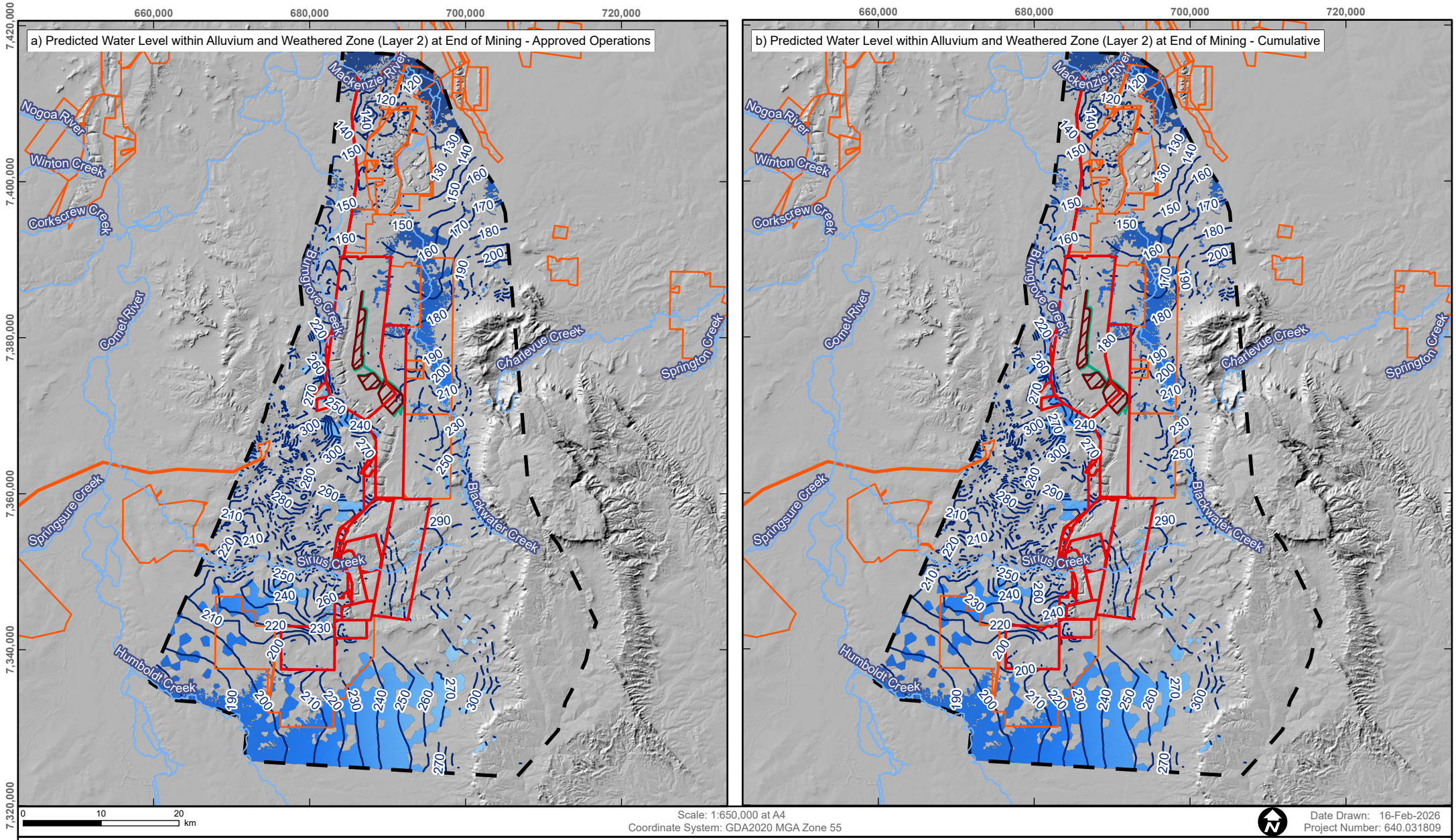
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BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

PREDICTED WATER LEVEL WITHIN THE ALLUVIUM AND TERTIARY (LAYER 1) AT THE END OF MINING

FIGURE 4-5

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F04_05_Predicted Water Level within the Alluvium and Tertiary (Layer 1) at the EOM



Scale: 1:650,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 16-Feb-2026
Project Number: 640.031809

SLR

Service Layer Credits:

Credits:
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LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area
- Groundwater Contour (mAHD)

Groundwater Level (mAHD)

334

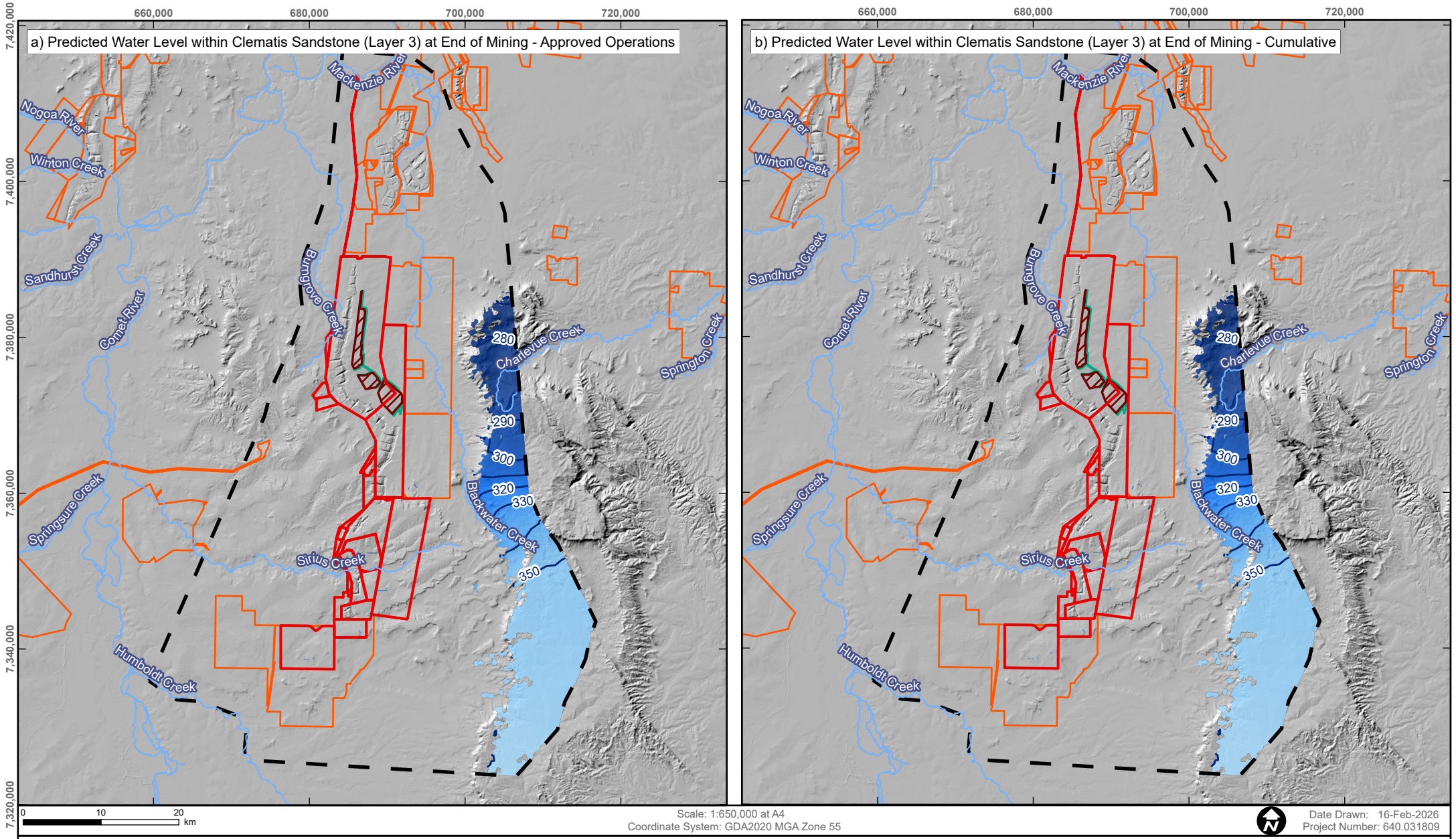
90

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

PREDICTED WATER LEVEL WITHIN THE ALLUVIUM AND WEATHERED ZONE (LAYER 2) AT THE END OF MINING

FIGURE 4-6

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F04_06_Predicted Water Level within the Alluvium and Weathered Zone (Layer 2) at the EOM



Scale: 1:650,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 16-Feb-2026
Project Number: 640.031809

SLR

Service Layer Credits:

Credits:

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LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area
- Groundwater Contour (mAHD)

Groundwater Level (mAHD)

363

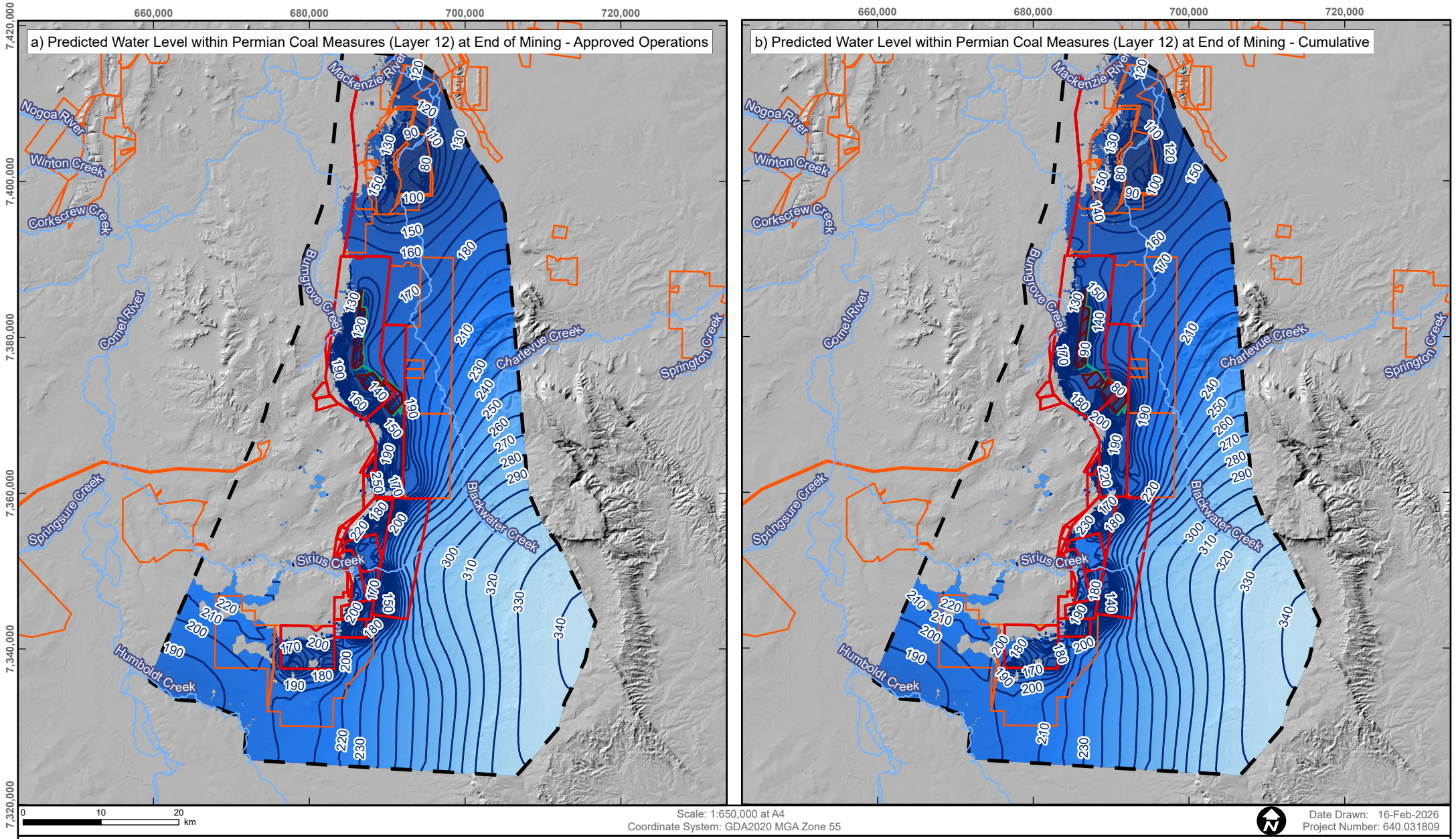
256

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

PREDICTED WATER LEVEL WITHIN THE CLEMATIS SANDSTONE (LAYER 3) AT THE END OF MINING

FIGURE 4-7

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F04_07_Predicted Water Level within the Clematis Sandstone (Layer 3) at the EOM



Scale: 1:650,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 16-Feb-2026
Project Number: 640.031809

SLR

Service Layer Credits:

Credits:
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LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area
- Groundwater Contour (mAHD)

Groundwater Level (mAHD)

342

68

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

PREDICTED WATER LEVEL WITHIN THE PERMIAN COAL MEASURES (LAYER 12) AT THE END OF MINING

FIGURE 4-8

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F04_08_Predicted Water Level within the Permian Coal Measures (Layer 12) at the EOM

4.4 Maximum Predicted Drawdowns

The process of mining directly removes water from the groundwater system and reduces water levels in surrounding groundwater units. The extent of the zone affected is dependent on the properties of the aquifers/aquitards and is referred to as the zone of drawdown. Aquifer drawdown is greatest at the working coalface and decreases with distance from the mine.

4.4.1 Maximum Incremental Drawdowns

Maximum incremental drawdown refers to the drawdown impact associated with the Project and is obtained by subtracting the predicted maximum aquifer groundwater drawdown for the Approved model scenario (Null – Approved) over the model duration from the predicted maximum aquifer groundwater drawdown for the Cumulative model scenario (Null – Project) over the model duration. The maximum drawdown represents the maximum drawdown values recorded at each model cell. Predicted incremental drawdown figures are presented in **Figure 4-9** to **Figure 4-16**, on the left side.

Figure 4-9 (a) shows that no incremental drawdown greater than (>) 1 m are predicted for the alluvium as a result of mining at the Project. For a discussion on the potential incidental water impacts on the alluvium, see **Section 4.6.1**. The maximum predicted incremental drawdowns associated with the Project within the weathered zone is shown in **Figure 4-10** (a). The incremental drawdown extent within the weathered zone (Layer 2) is largely confined to near the pit and is influenced by the distribution of predicted saturated zones in the weathered zone.

Figure 4-11 (a), **Figure 4-12** (a), and **Figure 4-13** (a) show the maximum predicted incremental drawdown in the Upper, Middle and Lower Rewan Formation, respectively. Drawdown increases with depth across the Rewan Formation, with Layer 6 showing incremental drawdown associated with the Project. The incremental drawdown extent is largely confined to near the pit, and in the lower Rewan. The lower Rewan is expected to be primarily disconnected from shallow receptors, and the drawdown does not propagate into the upper Rewan.

The Permian coal seams are the primary aquifers targeted by the Project and will experience drawdowns as a direct result of mining at the Project. Groundwater level drawdown within the mined coal seams is influenced by unit structure and is confined to unit extents. **Figure 4-14** (a) and **Figure 4-15** (a) show the maximum predicted incremental drawdown for the Aries and Pollux Seams in the RCM, respectively. The figures show that to the west, the extent of maximum predicted incremental drawdown of the Permian coal measures is limited to near the pit due to the structural geology (i.e., coal seams subcrop). The extent of maximum predicted incremental drawdown in the coal seams towards the east extends laterally to Blackwater Creek, however at depth, not vertically into the shallow formations, such as alluvium or Tertiary.

Maximum predicted incremental drawdown for the Burngrove Formation is shown in **Figure 4-16** (a). The figure shows that maximum predicted incremental drawdown is similar to the drawdown in the coal seams and is limited to the coal seam outcrop.

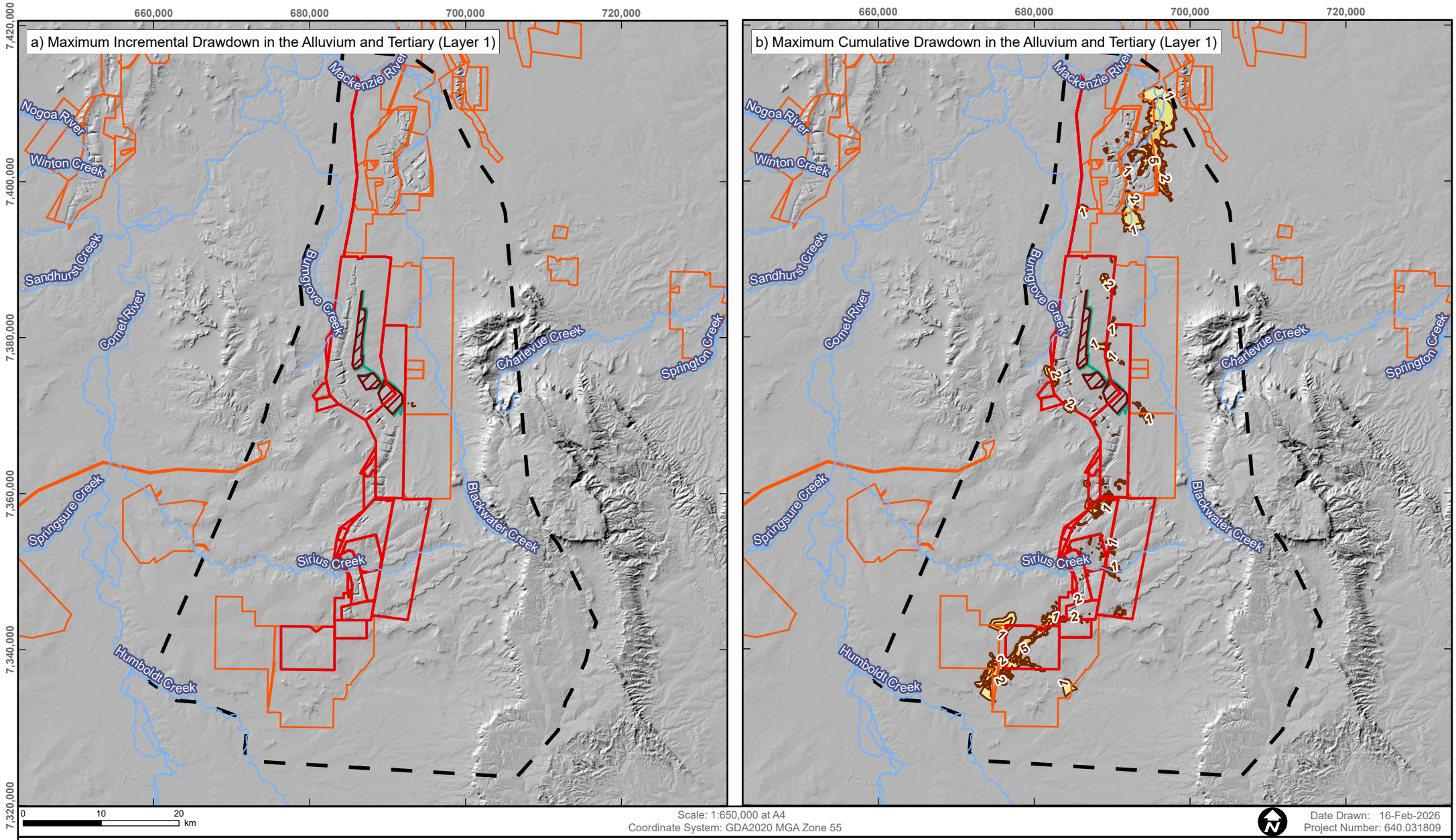
4.4.2 Maximum Cumulative Drawdowns

Maximum cumulative drawdown predicted impacts are shown in **Figure 4-9** to **Figure 4-16**, on the right side. These drawdowns represent the total impact of mining by all current mining and foreseeable mining, including the Project. The cumulative drawdown is derived by calculating the maximum difference in the groundwater levels for the Cumulative scenario with those in a theoretical “No Mining” or Null Run scenario, for all times during the predictive model period.

Cumulative drawdown impacts for the Alluvium and Tertiary (**Figure 4-9**, [b]) show that maximum predicted cumulative drawdown impacts are in the north near Blackwater Creek. Cumulative impacts within the weathered zone (**Figure 4-10**, [b]) can be seen connecting to the drawdown in the Tertiary.

Figure 4-14 (b) and **Figure 4-15** (b) show the maximum predicted cumulative drawdown in the Aries and Pollux seams in the RCM. As shown in the figures the maximum cumulative drawdown is bounded on the western side by the coal seam outcrop and predicted to extend generally a distance of 5-7 km east of the mining areas. The cumulative drawdown reached the model boundary in the northeast, which coincides with a major fault. An extension of the model in that area would still result in the same drawdown, as the fault is expected to act as a barrier to flow.

Figure 4-16 (b) shows the maximum predicted cumulative drawdown in the Burngrove Formation. The maximum cumulative drawdown for Burngrove is similar to the drawdowns expected in the Permian coal measures and predicted to extend approximately 5-7 km east of the mining areas.



Scale: 1:650,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 16-Feb-2026
Project Number: 640.031809

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Study Area
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area
- Drawdown Contour (m)

Drawdown (m)

1 - 2	20 - 50
2 - 5	50 - 100
5 - 10	100 - 200
10 - 20	200 - 300

SLR

Service Layer Credits:

Credits:

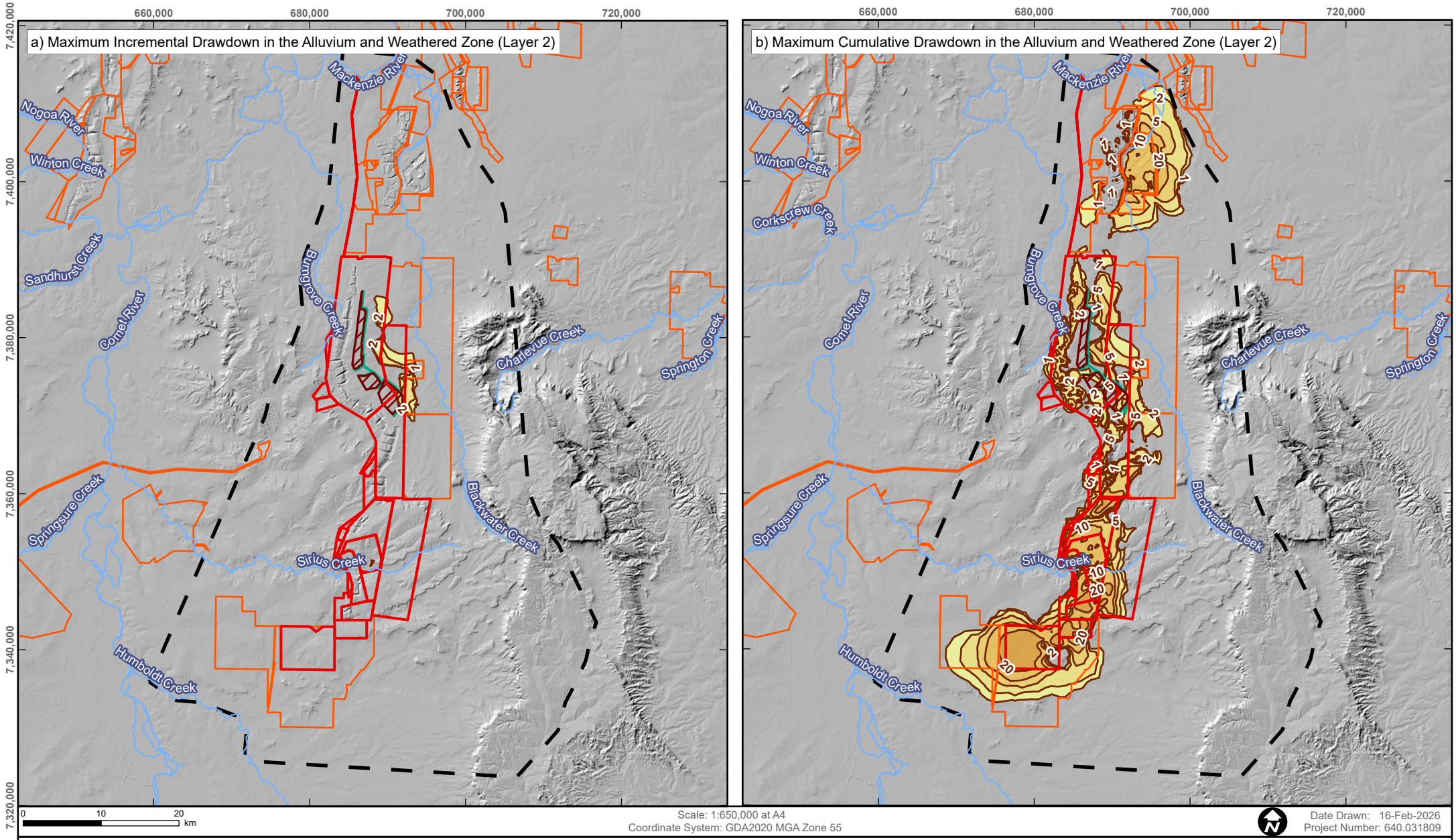
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BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

MAXIMUM INCREMENTAL (A) AND CUMULATIVE (B) DRAWDOWN IN THE ALLUVIUM AND TERTIARY (LAYER 1)

FIGURE 4-9

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F04_09_Maximum Incremental (a) and Cumulative (b) Drawdown in the Alluvium and Tertiary (Layer 1)



Scale: 1:650,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 16-Feb-2026
Project Number: 640.031809

LEGEND

- Watercourse
- BWM Mining Lease
- Model Boundary
- Mining Lease
- Proposed Open Cut Extension
- Proposed Infrastructure Area
- Drawdown Contour (m)

Drawdown (m)

1 - 2	20 - 50
2 - 5	50 - 100
5 - 10	100 - 200
10 - 20	200 - 300

SLR

Service Layer Credits:

Credits:

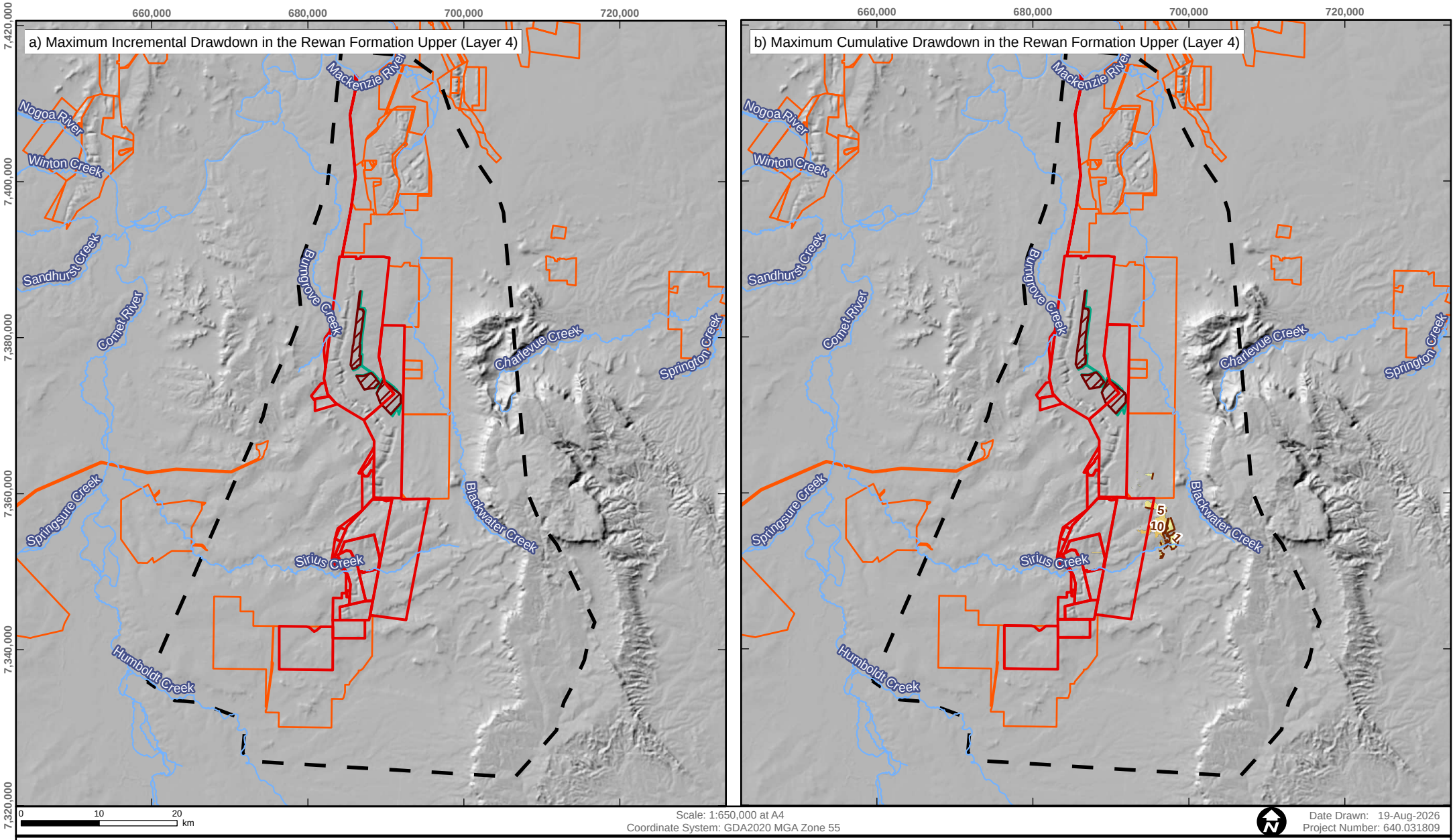
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BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

MAXIMUM INCREMENTAL (A) AND CUMULATIVE (B) DRAWDOWN IN THE ALLUVIUM AND WEATHERED ZONE (LAYER 2)

FIGURE 4-10

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F04_10_Maximum Incremental (a) and Cumulative (b) Drawdown in the Alluvium and Weathered Zone (Layer 2)



Scale: 1:650,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 19-Aug-2026
Project Number: 640.031809

LEGEND

- Watercourse
- Drawdown Contour (m)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Drawdown (m)

- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- 200 - 300

SLR

Service Layer Credits:

Credits:

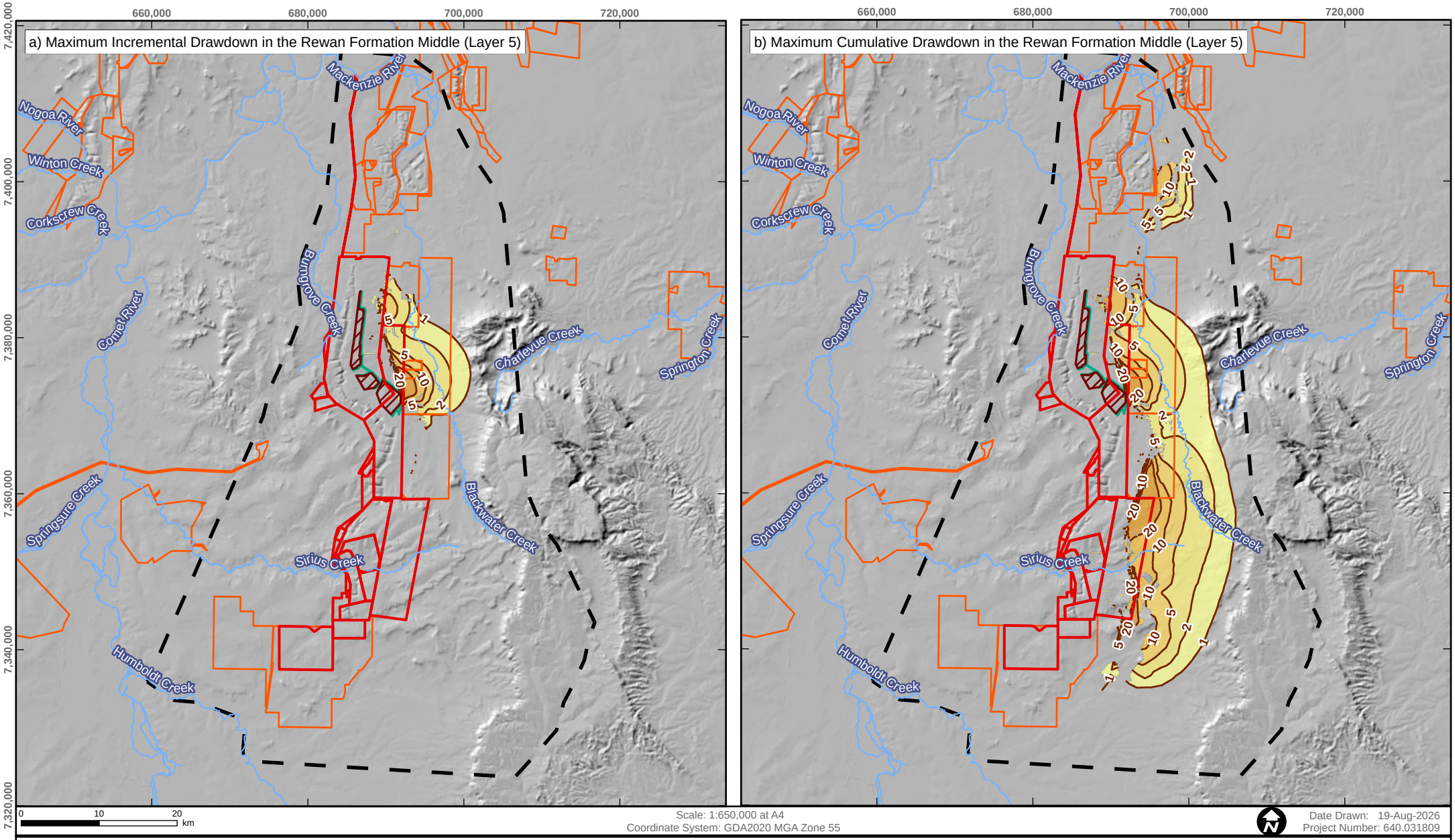
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BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

MAXIMUM INCREMENTAL (A) AND CUMULATIVE (B) DRAWDOWN IN THE REWAN FORMATION UPPER (LAYER 4)

FIGURE 4-11

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_FXX_Maximum Incremental (a) and Cumulative (b) Drawdown in the Rewan Formation Upper (Layer 4)



Scale: 1:650,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 19-Aug-2026
Project Number: 640.031809

LEGEND

- Watercourse
- Drawdown Contour (m)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Drawdown (m)

1 - 2	20 - 50
2 - 5	50 - 100
5 - 10	100 - 200
10 - 20	200 - 300

SLR

Service Layer Credits:

Credits:

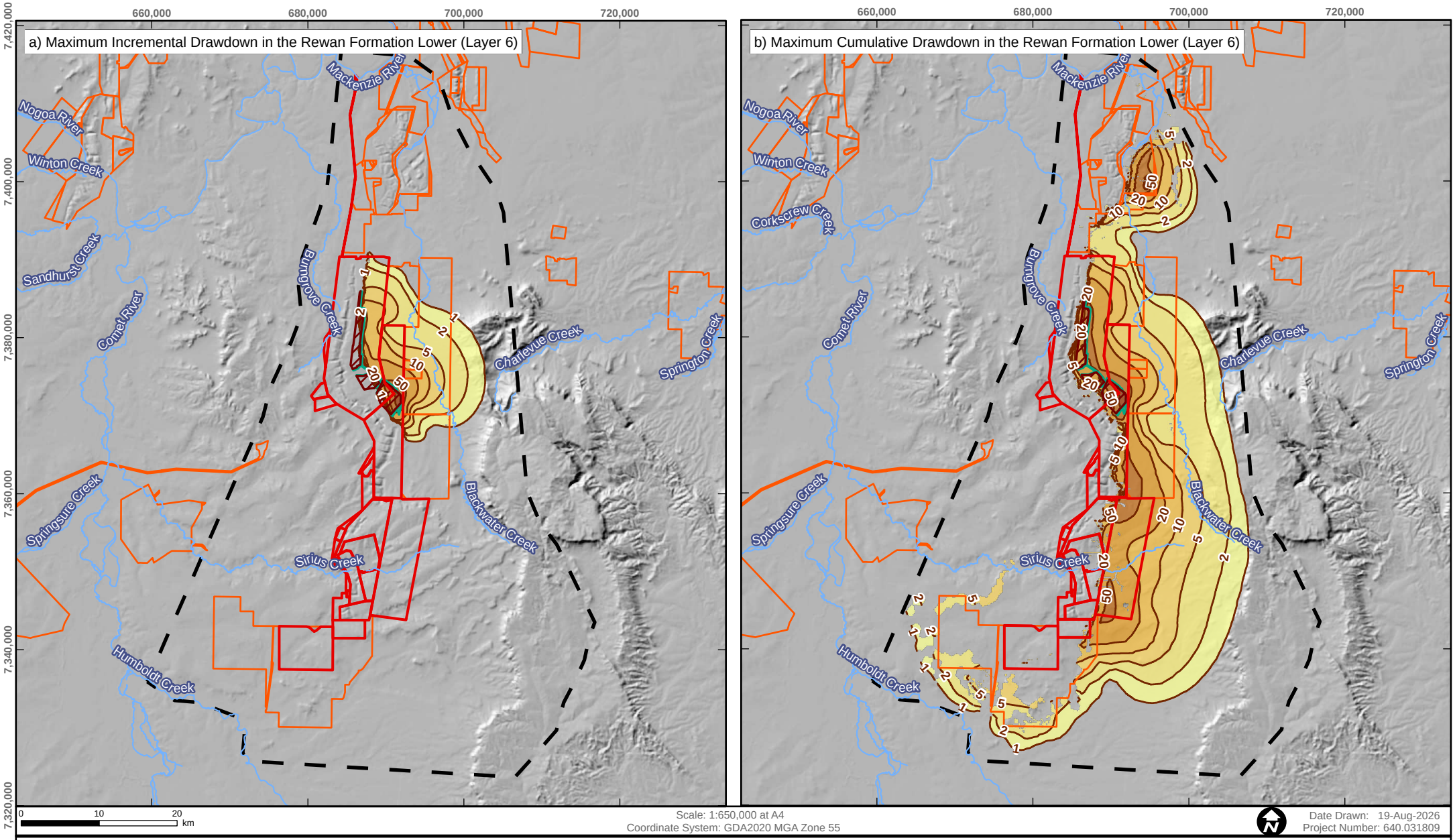
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BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

MAXIMUM INCREMENTAL (A) AND CUMULATIVE (B) DRAWDOWN IN THE REWAN FORMATION MIDDLE (LAYER 5)

FIGURE4-12

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_FXX_Maximum Incremental (a) and Cumulative (b) Drawdown in the Rewan Formation Middle (Layer 5)



Scale: 1:650,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 19-Aug-2026
Project Number: 640.031809

SLR

Service Layer Credits:

Credits:

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LEGEND

- Watercourse
- Drawdown Contour (m)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Drawdown (m)

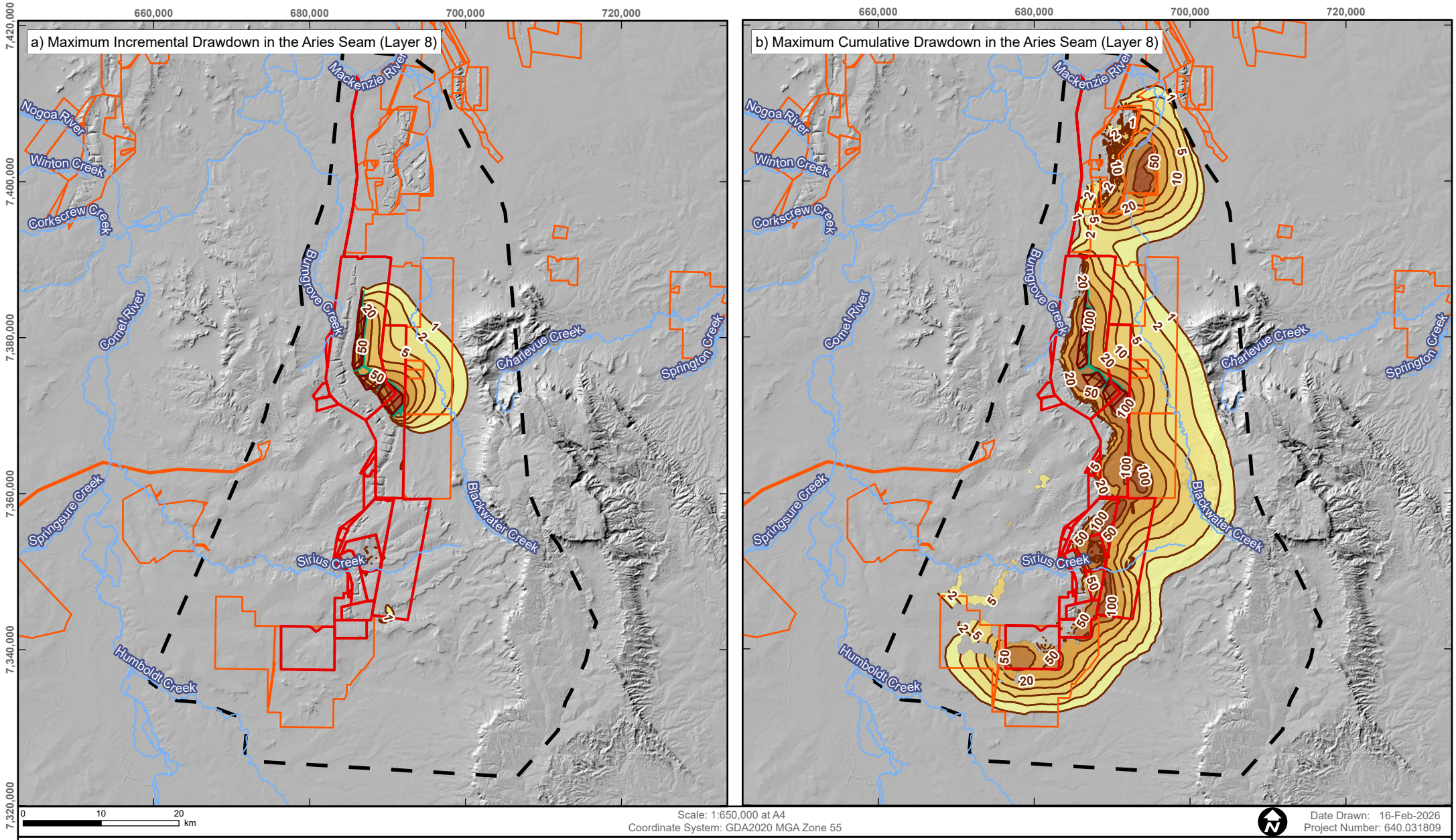
- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- 200 - 300

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

MAXIMUM INCREMENTAL (A) AND CUMULATIVE (B) DRAWDOWN IN THE REWAN FORMATION LOWER (LAYER 6)

FIGURE 4-13

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_FXX_Maximum Incremental (a) and Cumulative (b) Drawdown in the Rewan Formation Lower (Layer 6)



Scale: 1:650,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 16-Feb-2026
Project Number: 640.031809

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Study Area
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area
- Drawdown Contour (m)

Drawdown (m)

1 - 2	20 - 50
2 - 5	50 - 100
5 - 10	100 - 200
10 - 20	200 - 300

SLR

Service Layer Credits:

Credits:

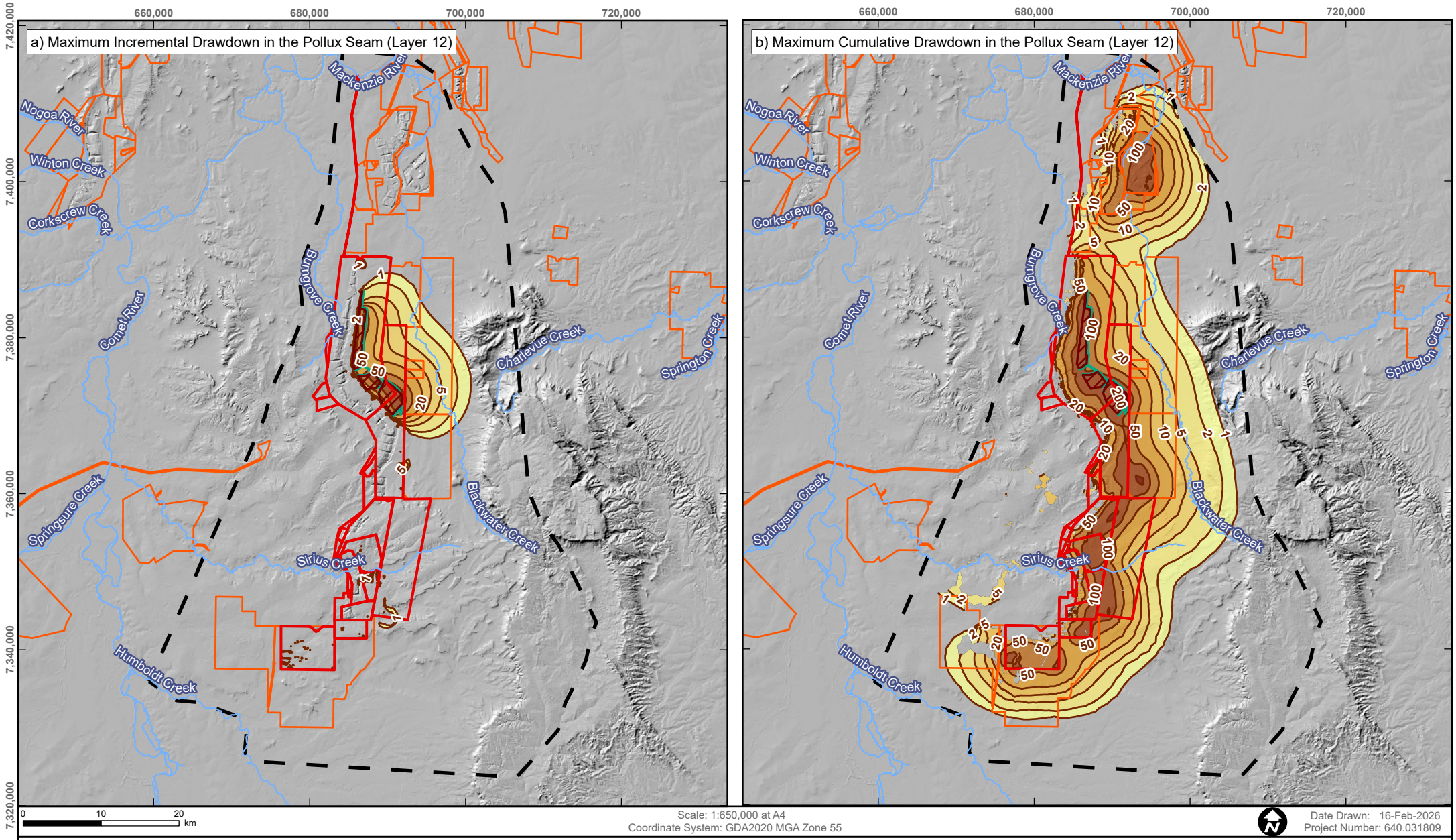
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BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

MAXIMUM INCREMENTAL (A) AND CUMULATIVE (B) DRAWDOWN IN THE ARIES SEAM (LAYER 8)

FIGURE 4-14

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F04_11_Maximum Incremental (a) and Cumulative (b) Drawdown in theAries Seam (Layer 8)



0 10 20 km

Scale: 1:650,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 16-Feb-2026
Project Number: 640.031809

SLR

Service Layer Credits:

Credits:

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LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Study Area
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area
- Drawdown Contour (m)

Drawdown (m)

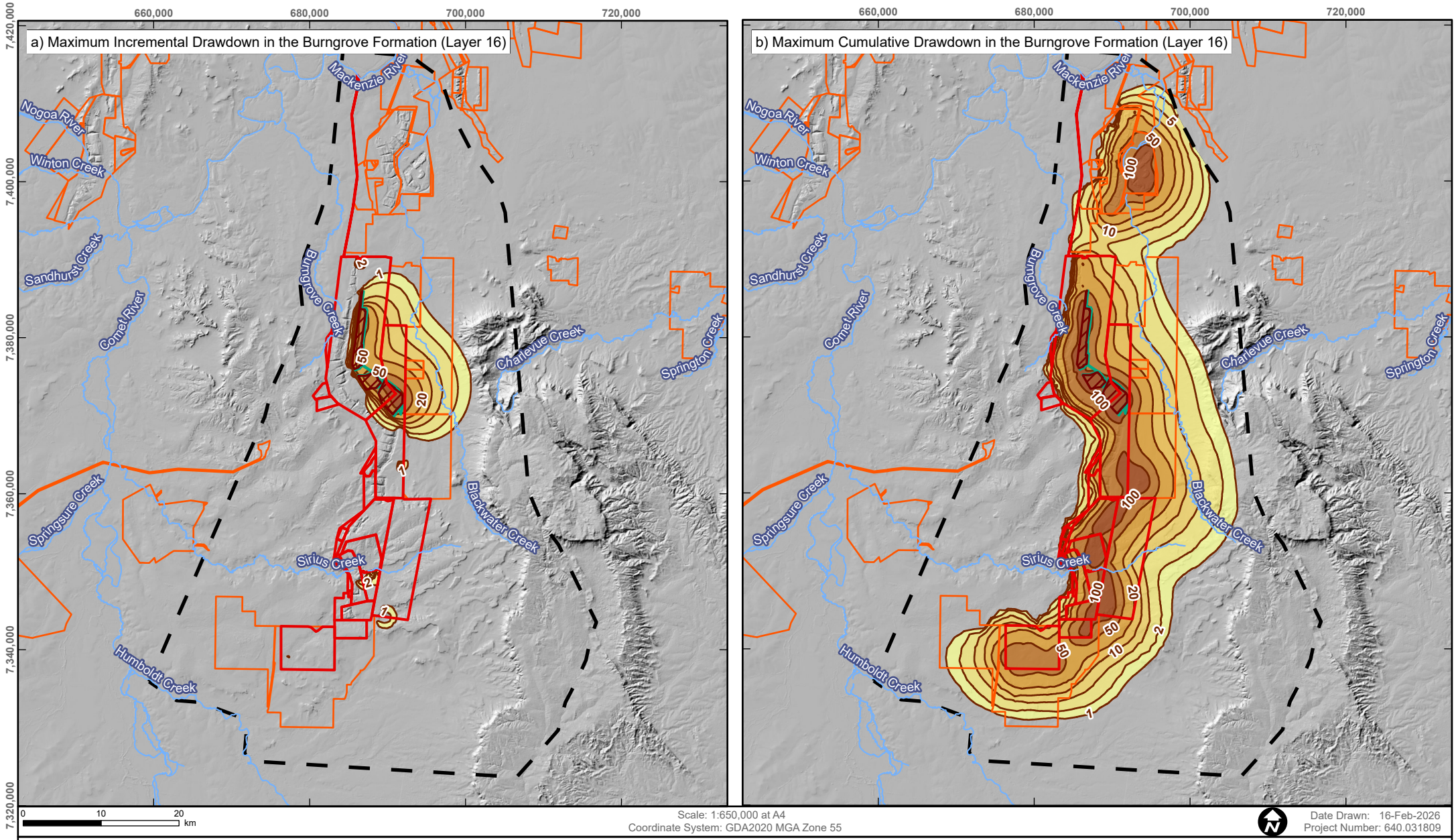
1 - 2	20 - 50
2 - 5	50 - 100
5 - 10	100 - 200
10 - 20	200 - 300

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

MAXIMUM INCREMENTAL (A) AND CUMULATIVE (B) DRAWDOWN IN THE POLLUX SEAM (LAYER 12)

FIGURE 4-15

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F04_12_Maximum Incremental (a) and Cumulative (b) Drawdown in the Pollux Seam (Layer 12)



Scale: 1:650,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 16-Feb-2026
Project Number: 640.031809

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area
- Drawdown Contour (m)

Drawdown (m)

1 - 2	20 - 50
2 - 5	50 - 100
5 - 10	100 - 200
10 - 20	200 - 300

SLR

Service Layer Credits:

Credits:

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BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

MAXIMUM INCREMENTAL (A) AND CUMULATIVE (B) DRAWDOWN IN THE BURNGROVE FORMATION (LAYER 16)

FIGURE 4-16

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F04_13_Maximum Incremental (a) and Cumulative (b) Drawdown in the Burngrove Formation (Layer 16)

4.5 Predicted Groundwater Interception

The mine inflow volumes have been calculated as time weighted averages of the outflow reported by Zone Budget software for the relevant drain cells. The predicted inflows for the Cumulative inflows (Approved mining and the Project) and the Incremental inflows (the Project only) are presented in **Figure 4-17**.

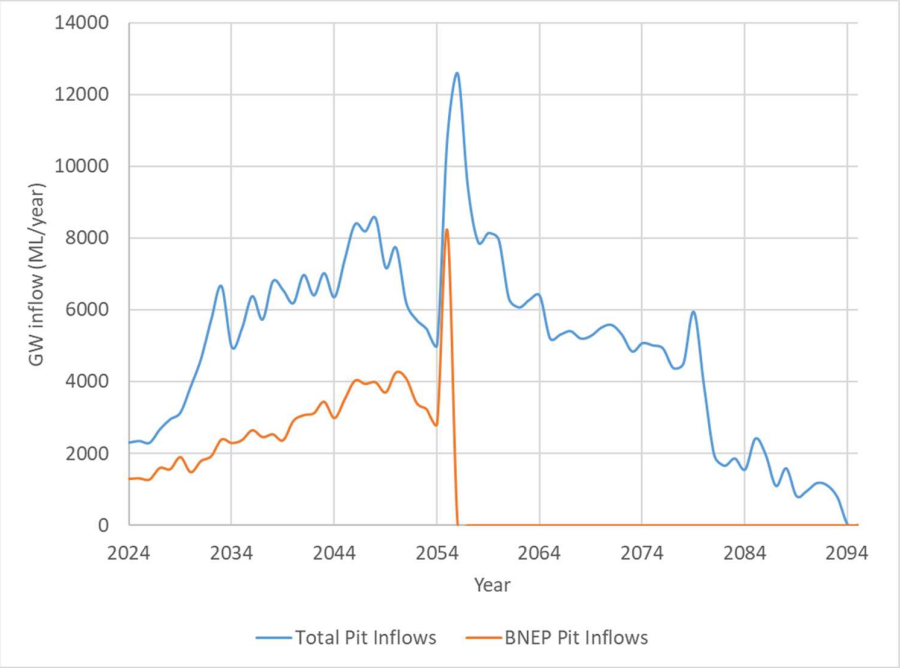


Figure 4-17 Predicted Cumulative and Incremental Project Mine Inflows

Cumulative inflows are predicted to range between 2,290 ML/year and 12,585 ML/year from year 2025 and 2056, peaking in 2056, then decrease until end of mining. The average predicted cumulative mine inflow rate (2025 to 2093) is 5,139 ML/year (14.1 ML/day). The spike in cumulative inflows in 2056 is due to the commencement of the southern mining operations, which are not part of the BNEP and thus the incremental is 0 ML/year.

The incremental inflows into the mine pits on SA 7 and SA 10 are predicted to reach a maximum in year 2055, with a peak just above 8,200 ML/year (22.5 ML/day). The average project mine inflow rate for the Project (2025 to 2055) is 2,272 ML/year (6.2 ML/day).

The Water Plan (Fitzroy Basin) 2011 groundwater area consists of the following:

- Groundwater Unit 1 (containing aquifers of the Quaternary alluvium).
- Groundwater Unit 2 (sub-artesian aquifers).

Planned mining operations at the Project will not intercept Quaternary alluvium at any of the proposed pits. As such, all direct groundwater take predicted by the model is from Groundwater Unit 2.

4.6 Incidental Water Impacts

4.6.1 Alluvium Take

The change in alluvial water resources was estimated by comparing water budgets for alluvial zones using the Approved and Cumulative scenarios of the predictive model. Interference of the alluvial groundwater can occur due to reduced upward leakage from Permian coal measures that are depressurised because of mining activities. Over the extent of Quaternary alluvium along Blackwater Creek, there is a maximum flow reduction of 0.5 ML/day (500 kilolitres per day [KL/day]) from underlying formation to alluvium as a result of the Project (**Figure 4-18**). This reduction represents a regional-scale response, as no specific areas of alluvium are predicted to experience drawdown > 1 m Layer 1 - Alluvium and Tertiary.

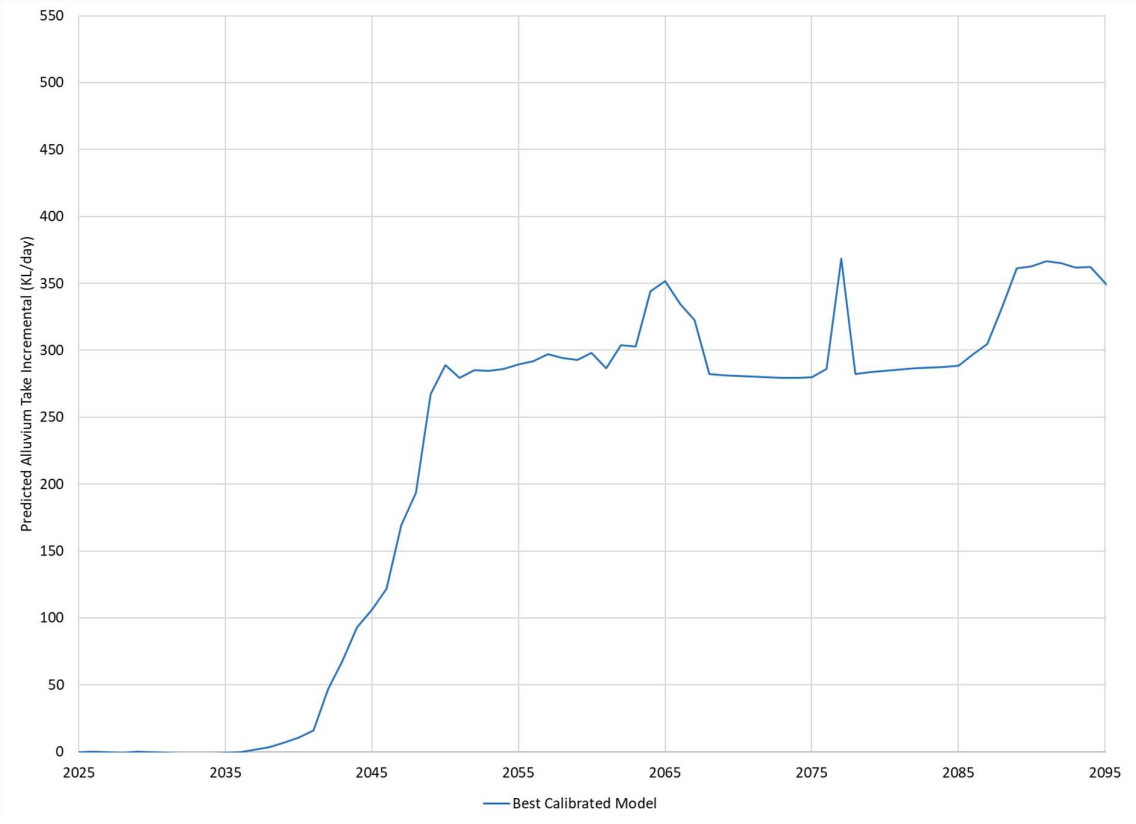


Figure 4-18 Predicted Alluvium Incremental Take

4.6.2 Groundwater – Surface Water Interaction

The change in groundwater flow to Blackwater Creek due to the Project was calculated by comparing the river flow budgets for Blackwater Creek in the Cumulative scenario against the Approved scenario (**Figure 4-19**). This calculation showed that over the life of mine, the maximum change of groundwater flow to Blackwater Creek is negligible (0.001 KL/day).

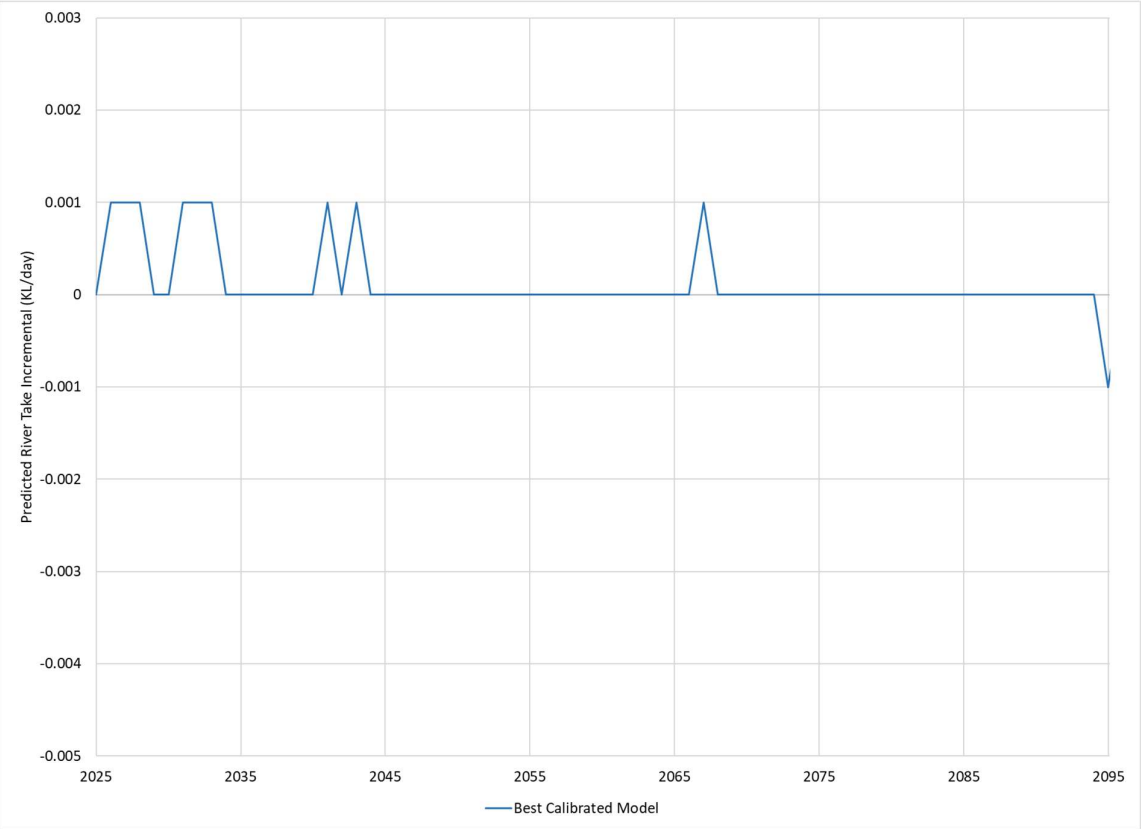


Figure 4-19 Predicted Incremental Loss in River Baseflow (Blackwater Creek)

4.6.3 Drawdown at Landholder Bores

Drawdown was assessed for landholder bores identified in a 5 km radius of the mining lease. **Table 4-4** lists the bores with their name, location, screened formation and use. The last two columns present the maximum incremental and cumulative drawdown predicted to occur at each location. Incremental drawdown from the Project is not predicted to be > 0.5 m at any bore. Only bores with casing depth information, and therefore, able to be assigned to a model layer, were assessed.

Table 4-4 Drawdown Impact on Landholder Bores

Registered RN (ID)	Bore name	Easting (GDA94 z55)	Northing (GDA94 z55)	Assumed Model Layer	Bore Depth (m)	Use	Maximum Incremental Drawdown (m)	Maximum Cumulative Drawdown (m)
38998	-	681119	7391492	Permian	36.6	Unknown	0	0
43097	-	681800	7392230	Permian	22.8	Water Supply	0	0
43459	Top Bore	683719	7395787	Permian	54.9	Unknown	0	0
57410	House well	674936	7345038	Weathered zone/Regolith	24.4	Unknown	0	0.2
57421	Home well	675898	7343916	Weathered zone/Regolith	30.5	Water Supply	0	4.7
57423	Mikes Bore	677244	7341916	Weathered zone/Regolith	38	Water Supply	0	23.2
57424	Plain Bore (OLD)	675422	7336214	Weathered zone/Regolith	39.6	Water Supply	0.5	13.7
57425	Plain Bore (NEW)	675596	7336268	Weathered zone/Regolith	39.6	Water Supply	0.5	14.6
57461	House Bore	692896	7340485	Triassic	28.9	Unknown	0	14.6
57462	Kulla well (1)	694367	7340239	Surface cover and Tertiary	4.9	Unknown	0	0
57463	Kulla well (2)	694678	7340159	Surface cover and Tertiary	7.6	Unknown	0	0
62660	Thomas Bore	672542	7339045	Interburden	100	Unknown	0.1	9.4
62663	Kevanaghs Bore	675228	7346704	Permian	43	Unknown	0	0
84221	-	683596	7390708	Permian	24	Unknown	0	0



Registered RN (ID)	Bore name	Easting (GDA94 z55)	Northing (GDA94 z55)	Assumed Model Layer	Bore Depth (m)	Use	Maximum Incremental Drawdown (m)	Maximum Cumulative Drawdown (m)
90446	-	686300	7340827	Permian	220	Water Supply	0	62.6
90447	-	685251	7340020	Permian	200	Water Supply	0	41.4
103345	-	684091	7363016	Permian	47	Water Supply	0	0.1
103347	-	678897	7350341	Permian	35	Water Supply	0	0
103348	-	678064	7347791	Permian	38	Water Supply	0	0
103349	-	679152	7345733	Permian	43	Water Supply	0	0.3
103388	-	687575	7340715	Triassic	32	Water Supply	0	21.3
103469	Walro Bore	673410	7335977	Interburden	171.13	Water Supply	0.3	9.5
111709	-	680013	7390877	Permian	72	Water Supply	0	0
132075	-	692910	7340474	Weathered zone/Regolith	9	Water Supply	0	0
158911	-	695505	7341762	Triassic	90	Unknown	0	10.3
165937	-	694749	7341252	Triassic	52	Water Supply	0	12
207590	-	683925	7368395	Surface cover and Tertiary	30	Domestic	0	0
207592	-	685877	7368329	Permian	36	Stock	0	1
208967	-	694466	7340032	Triassic	18	Stock	0	9.9
Unregistered 1	-	671980	7343932	Weathered zone / Regolith	33	Stock	0	0.1
Unregistered 10	-	681315	7380737	Permian	49	Not in use	0	0

5.0 Predictive Modelling – Post Mining

5.1 Timing

The potential post mining impacts of the Project were investigated through a post mining period, commencing at the end of mining at the Project and extending for 1,947 years until the model reached equilibrium. The stress period lengths for the post mining periods are shown in **Table 5-1**. In total, there are 38 stress periods of varying lengths.

Table 5-1 Stress Period Set-up for Post Mining Model

Stress Period	Date Range	Time Interval
155 - 167	01/01/2094 – 31/12/2110	Annual
168	01/01/2111 – 31/12/2120	10 years
169	01/01/2121 – 31/12/2140	20 years
170 - 189	01/01/2141 – 31/12/4040	50 years and greater

The above post mining stress periods were added to the predictive model to ascertain post-mining inflows, with all drain cells removed.

5.2 Final Voids Inflows

The indicative location of the 15 final voids (with three voids in the Project area and two voids in the immediate vicinity of the Project area) at the Project is provided in **Figure 5-1**. The cells were assigned high horizontal and vertical hydraulic conductivities (1000 m/day) and storage parameters based on the compressibility of water (specific yield of 1.0, storage coefficient of 5.0×10^{-6} m^{-1}), to simulate free water movement within the final voids. This approach is often referred to as a 'high-K' lake. There are 10 other final voids, not located in the immediate vicinity of the Project area (but within the BWM site), which have also been modelled.

5.2.1 Methodology

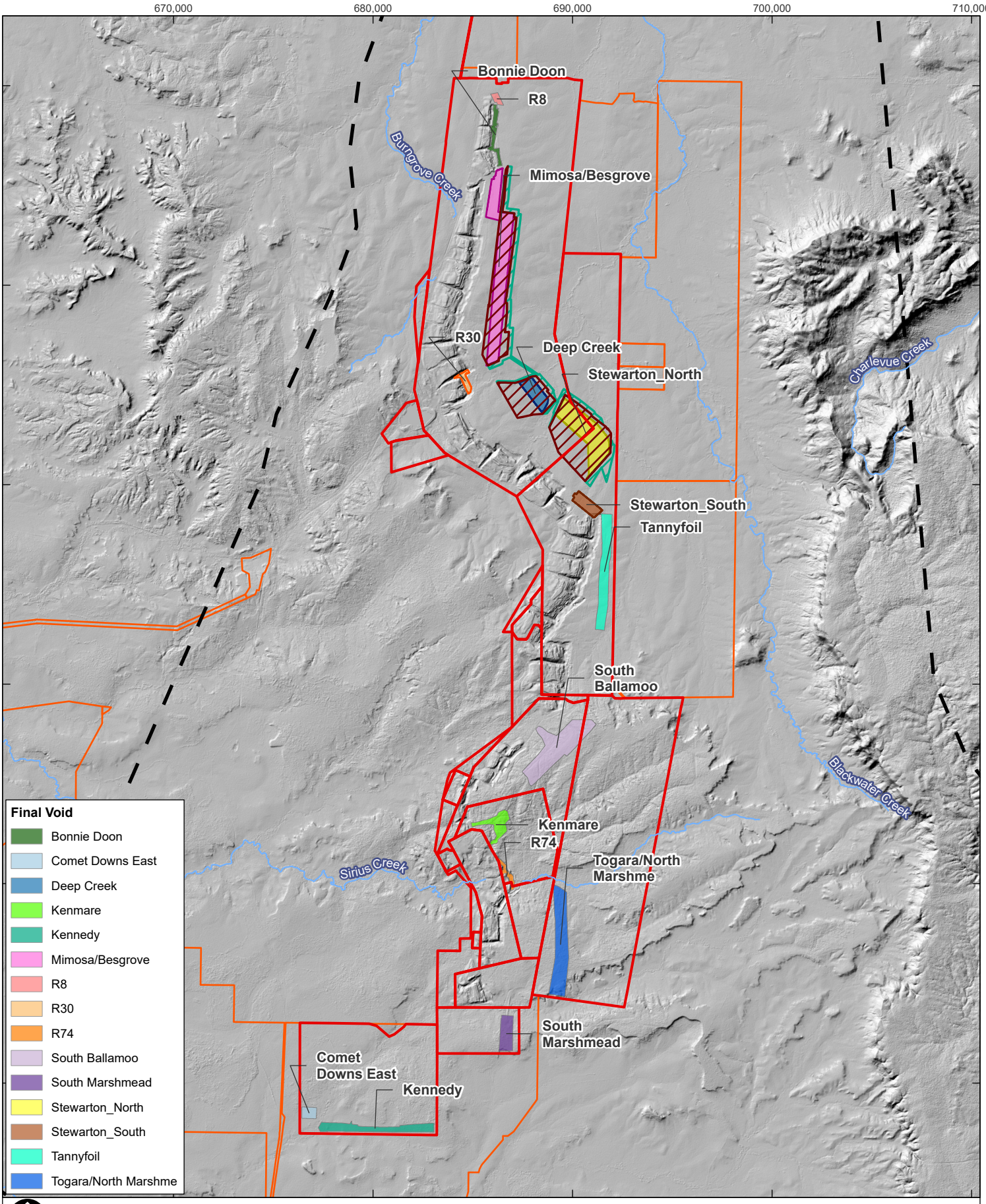
The following methodology was used to allow convergence between the groundwater and water balance models with respect to void lakes. The groundwater modelling methodology involves a stepwise iterative process with the water balance model:

1. Initial predicted groundwater inflows with time to the voids from the groundwater model were incorporated in the initial water balance model.
2. The pit lake recovery levels and timings were then predicted by the water balance model, incorporating both groundwater and surface water fluxes and processes.
3. The void water elevations and recovery timings derived from the water balance modelling were then replicated within the numerical groundwater recovery model using the time variant constant head boundary (CHD) condition, to refine the groundwater model prediction of void groundwater inflows and lake recovery.
4. Assessment was made to check that the refined groundwater model predictions for fluxes to the voids agree with what was used as input to the water balance modelling.

To avoid iterating many times between the groundwater model and the water balance model before reaching agreement, SLR used an automated process (using python code) that iterates between the groundwater model and the water balance model until a predefined convergence criteria is reached (Xiao et al., 2025). Not only does this automated process



save time, it also allows reaching full convergence between the groundwater and the water balance model, increasing confidence in the modelling process.



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	16-Feb-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Study Area
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

FINAL VOID LOCATIONS

SLR

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FIGURE 5-1

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F05_01_Indicative Final Void Locations

5.2.2 Results

Once the convergence was achieved, the resulting pit lake recovery curves (HydroBalance, 2026) for the five voids (**Figure 5-2**) were applied within the numerical groundwater model using time-variant constant head boundary conditions (CHD) to represent long-term equilibrium conditions. The groundwater model was subsequently run for 1,947 years.

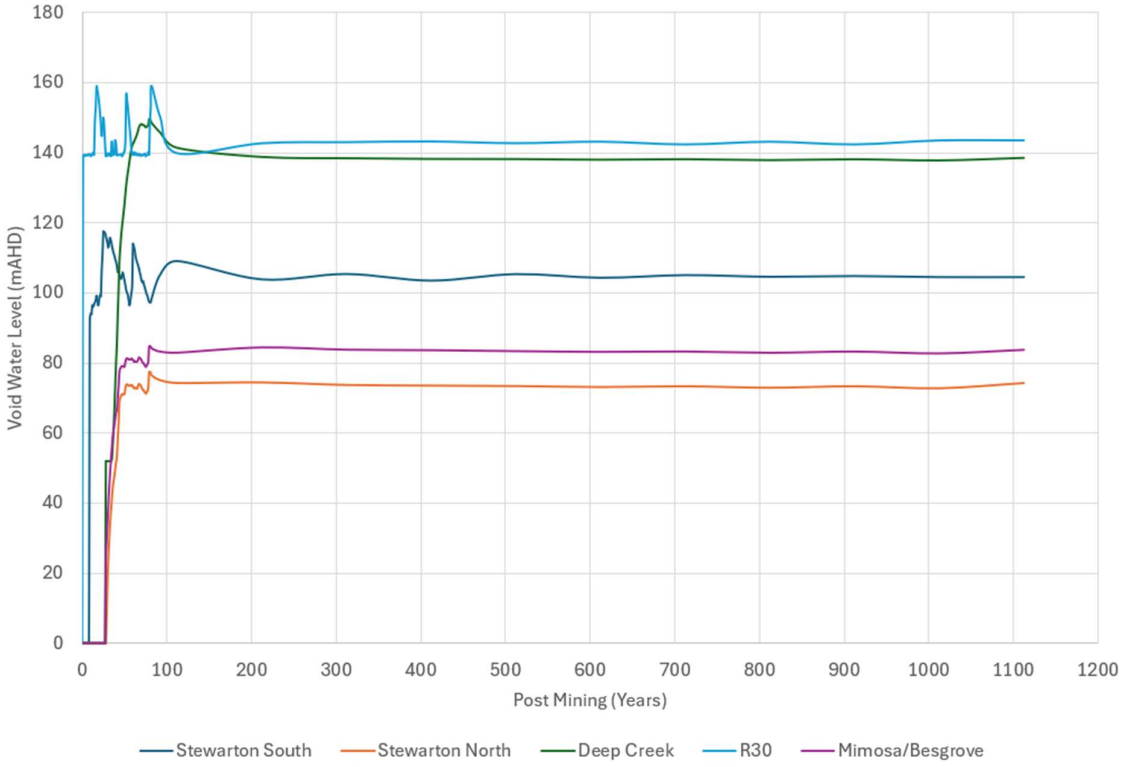


Figure 5-2 Final Void Recovery Curves

The equilibrated final void water levels are listed in **Table 5-2**. **Table 5-2** also lists the recovered water table to the east of the pits, at a distance of approximately 250 m. The head difference between the groundwater and the pit lake ranges between -21.88 m and 55.89 m for all pits.

Final void inflows are shown for all five voids from **Figure 5-3** to **Figure 5-7**. A positive flow value indicates a net inflow to the void while a negative value indicates a net outflow, from the void toward the local groundwater system. For each void, the net flux to the void is categorised based on its origin: Fluxes from spoil material to the void is shown as “Spoil to void”, while fluxes from the in-situ native rock to the void is show as “native rock to void”.

Final void Stewarton South and R30 show a constant negative net flux, indicating that water in the void primarily flow toward the local groundwater. The fate of these water fluxes is further discussed in **Section 5.3**.

Table 5-2 Final Voids – Equilibrium Water Levels and Groundwater Levels (From North to South)

Component	Equilibrium Void Water Level (mAHD)	Groundwater Level (mAHD)[1]	Head Difference (m)[2]
R8	144.98	150.56	5.58
Bonnie Doon	159.11	156.79	-2.32
Mimosa/Besgrove	83.8	131.1	47.3
R30	143.46	123.83	-19.63
Deep Creek	138.67	138.84	0.17
Stewarton_North	74.31	108.19	33.88
Stewarton_South	104.63	143.08	38.45
Tannyfoil	143.17	176.17	33
South Ballamoo	140.27	158.59	18.32
Kenmare	215.48	193.6	-21.88
R74	234.19	244.34	10.15
Togara/North Marshmead	163.86	219.75	55.89
South Marshmead	170.09	181.13	11.04
Comet Downs East	189.24	188.68	-0.56
Kennedy	160.8	173.06	12.26

1 Groundwater level extracted from the recovered water level map, read out approximately 250 m away from each pit to the east.
2 A positive number indicates gradient towards the void, a negative number would indicate a gradient away from void.

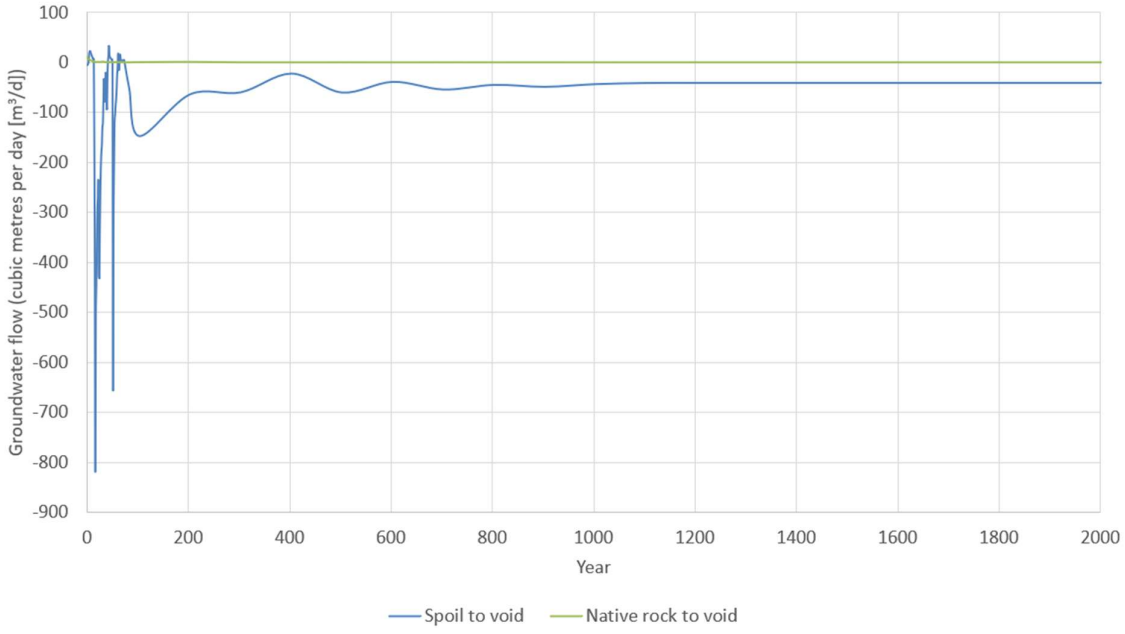


Figure 5-3 Post-mining Groundwater Inflows to Stewarton South

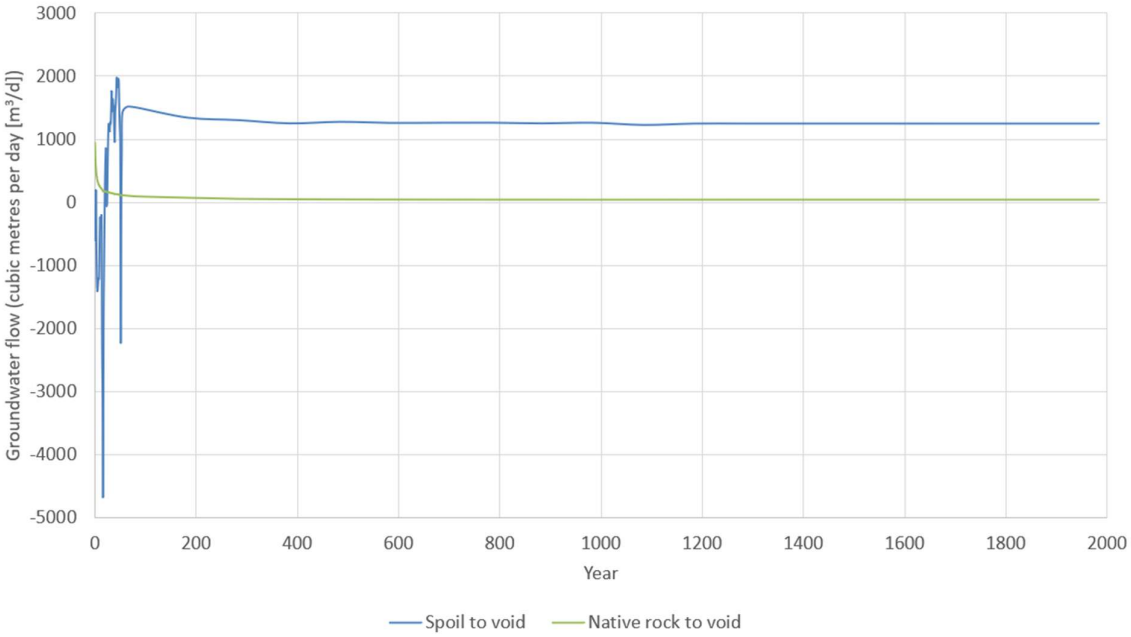


Figure 5-4 Post-mining Groundwater Inflows to Stewarton North

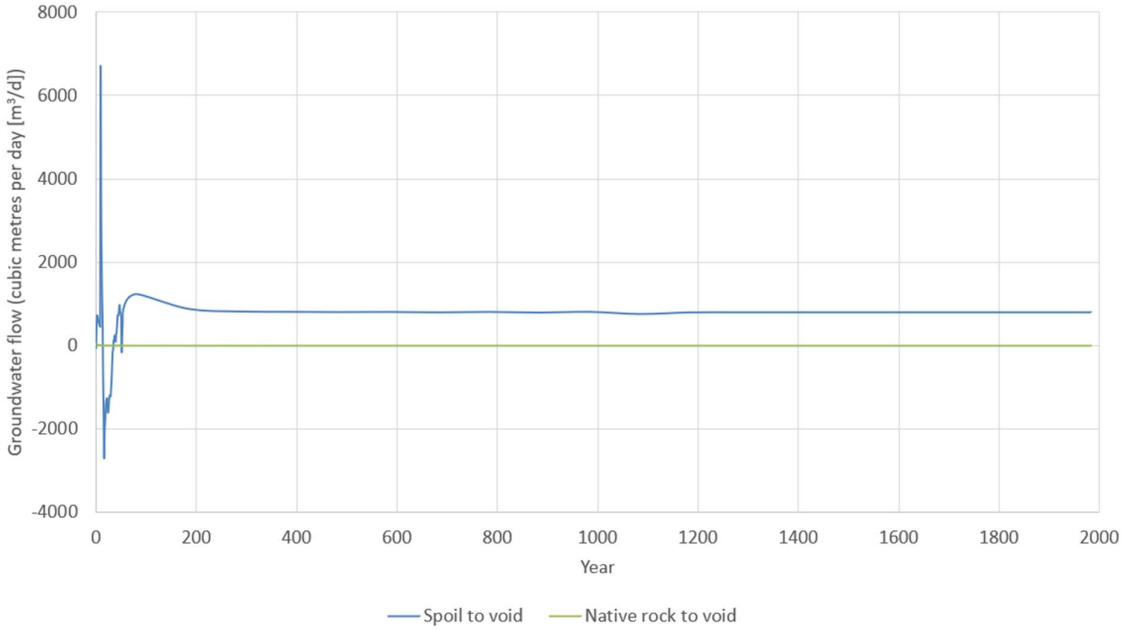


Figure 5-5 Post-mining Groundwater Inflows to Deep Creek

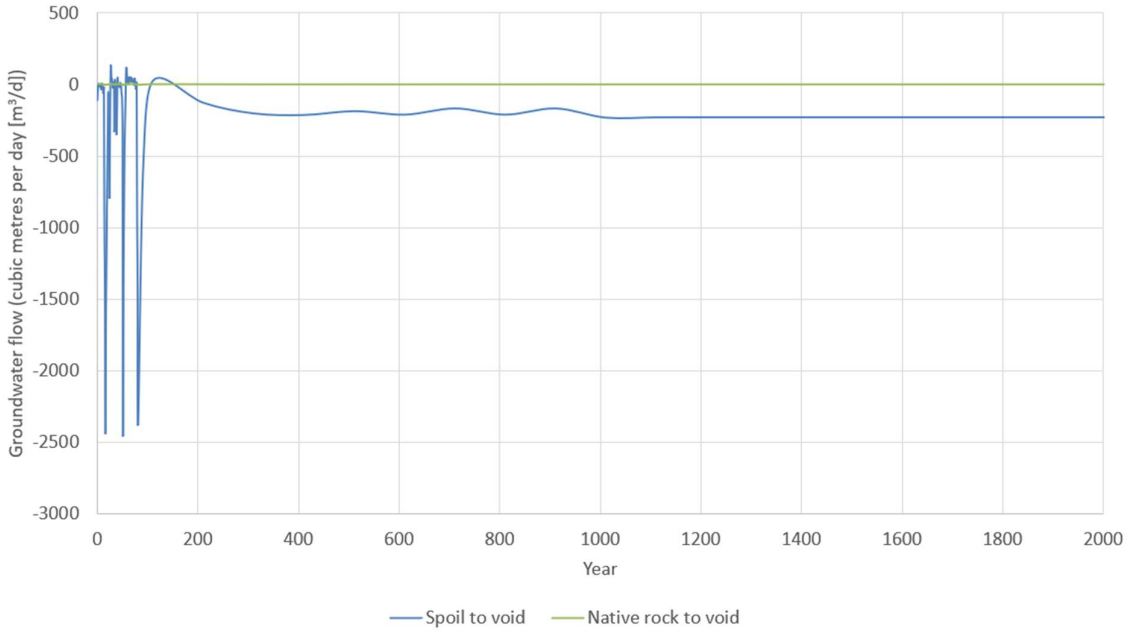


Figure 5-6 Post-mining Groundwater Inflows to R30

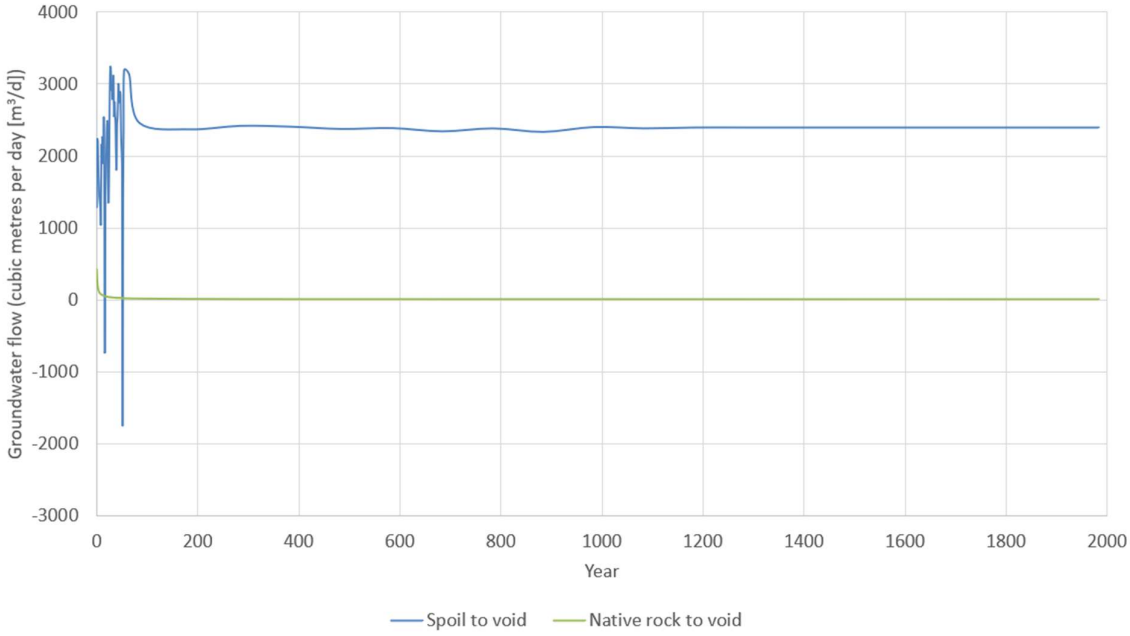
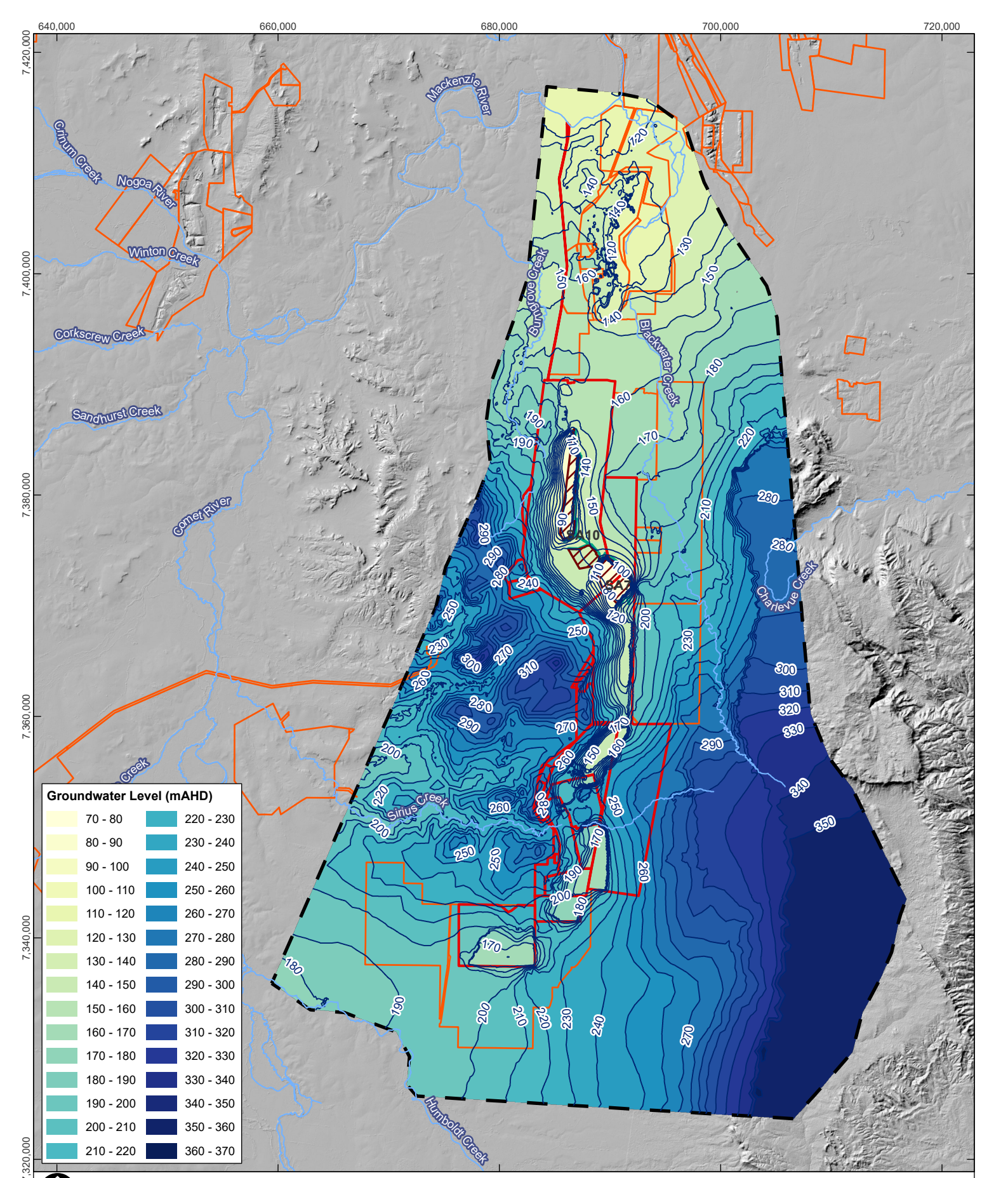


Figure 5-7 Post-mining Groundwater Inflows to Mimosa Besgrove

The predicted final groundwater water levels are presented in **Figure 5-8** and **Figure 5-9**. Predicted final groundwater levels for the Tertiary Sediments, Rewan Formation, Rangal Coal Measures and the Burngrove Formation are provided in **Appendix D.**



0 5 10 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:433,846 at A4
Project Number:	640.031809.00001
Date Drawn:	16-Feb-2026
Drawn by:	RB

LEGEND

- Groundwater Level Contour (m)
- Watercourse
- BWM Mining Lease
- Mining Lease
- Study Area
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

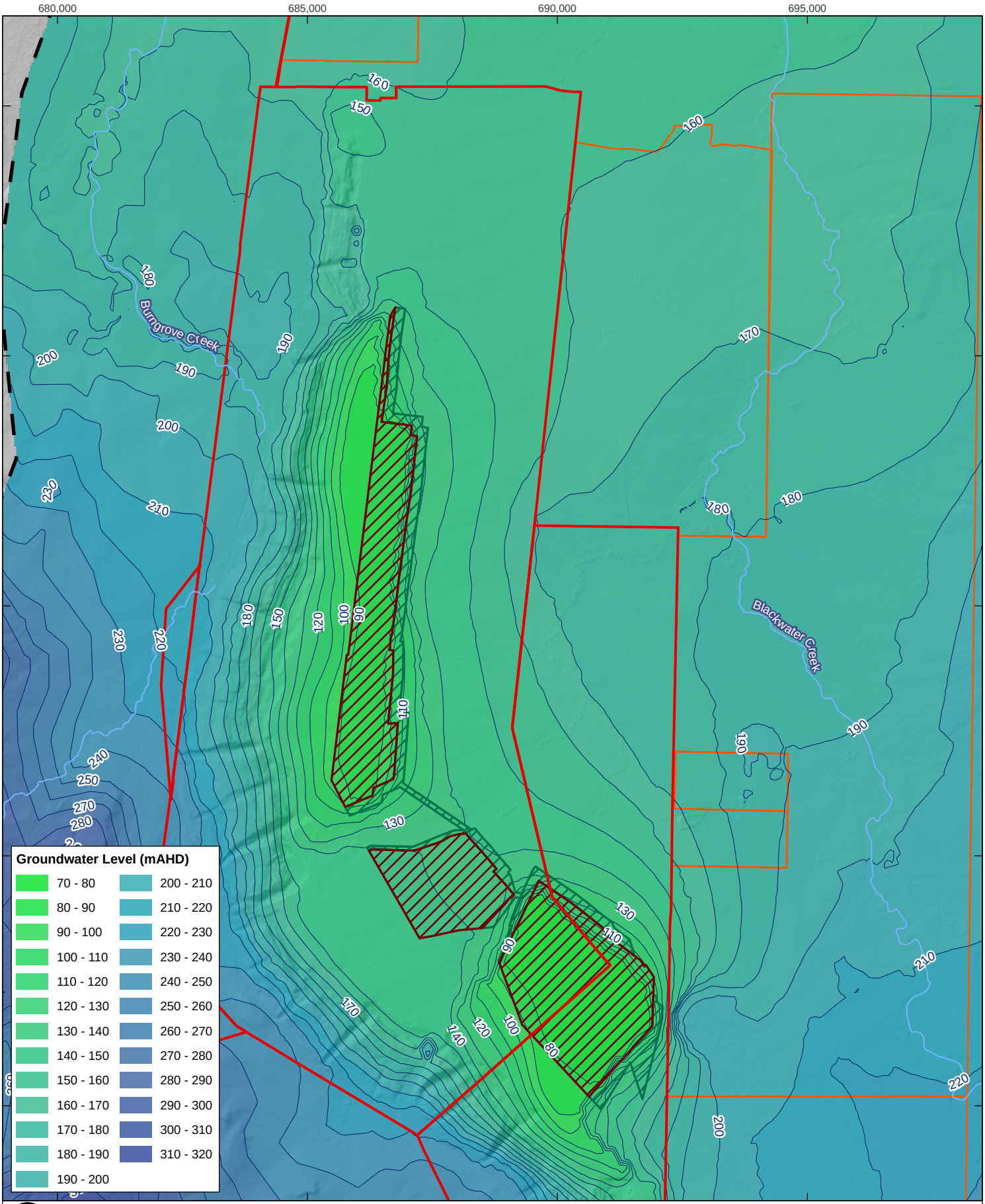
GROUNDWATER TABLE RECOVERY (POST-MINING)

SLR

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FIGURE 5-8

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F05_08_Groundwater Table Recovery (post-mining)



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	640.031809.00001
Date Drawn:	20-Aug-2026
Drawn by:	RB

LEGEND

- Groundwater Level Contour (m)
- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

GROUNDWATER TABLE RECOVERY (POST-MINING) - NORTHERN VOIDS

SLR

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FIGURE 5-9

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_FXX_Groundwater Table Recovery (post-mining)

5.3 Particle tracking

The mod-PATH3DU code (S.S. Papadopulos & Associates, Inc., 2020) was used to simulate particle pathways along the groundwater flow field post mining. To run the mod-PATH3DU code the transient head outputs from the groundwater flow model were used by mod-PATH3DU to simulate particle flow path lines.

The particles were placed on the final landform (landform 4.1) and within the residual voids (**Figure 5-10**), at the surface of the model (with the exception of particles placed within the underground mine workings adjacent to Laleham). Particle placed at the surface of the model are automatically moved to the shallowest saturated layer at the commencement of the simulation. Mod-PATH3DU was configured to release the particles at the midpoint between the base of the first saturated layer and the water table. As shown on **Figure 5-10** 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 BWM Area at the commencement of the post-mining simulation. The particles placed in the underground mines were configured to begin their simulation in the Pollux seam (Layer 12) to simulate the fate of water beginning in the flooded underground workings after mine closure.

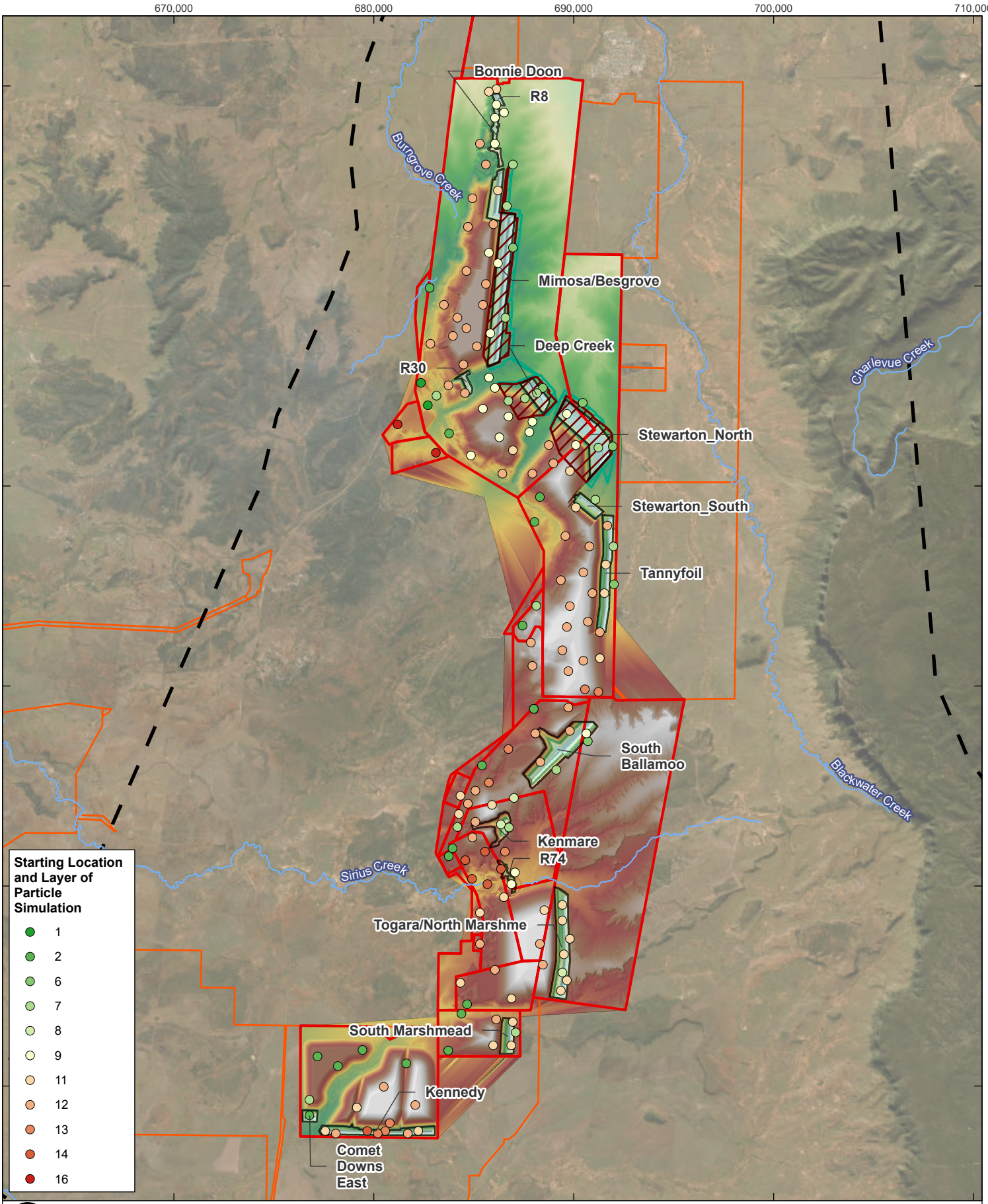
To estimate flow paths from the end of mining until post mining equilibrium, particles were released at the start of the post mining period (year 2093) and tracked until the end of the post mining simulation period (year 4040). **Figure 5-11** shows the predicted movement of water particles in the 1,947-year post mining simulation. The colours along the predicted particle flow paths provide the model layer the particle was simulated to be moving through, with the green to red scale classification representing particles moving from shallower to deeper model layers.

The colour changes along the paths on **Figure 5-11** 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. However, particles that begin in the Pollux seam (Layer 12) and other deeper layers often are observed to move upwards to shallower layers over the course of the recovery simulation, as the saturated water levels in the spoil and aquifers adjacent to the residual voids recover to their long-term post-mining equilibrium state. The flow path analysis indicates the particles generally move toward the void lakes, with the majority of the particles captured in the voids.

As discussed in **Section 5.2,** both Stewarton South and Ramp 30 are showing a negative net inflow; However, particle tracking indicates that fluxes from these voids do not flow to the regional groundwater and instead flow toward neighbouring voids. As shown on **Figure 5-11**:

- particles released into Stewarton South are captured by Stewarton North; and
- particles released into Ramp 30 are captured by Mimosa/Besgrove.

No particles are predicted to travel outside of the mine lease in the post-mining simulation.



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	17-Feb-2026
Drawn by:	AS

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Study Area
- Void Extent
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area

Final Landform Elevation (mAHD)

450

-5

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

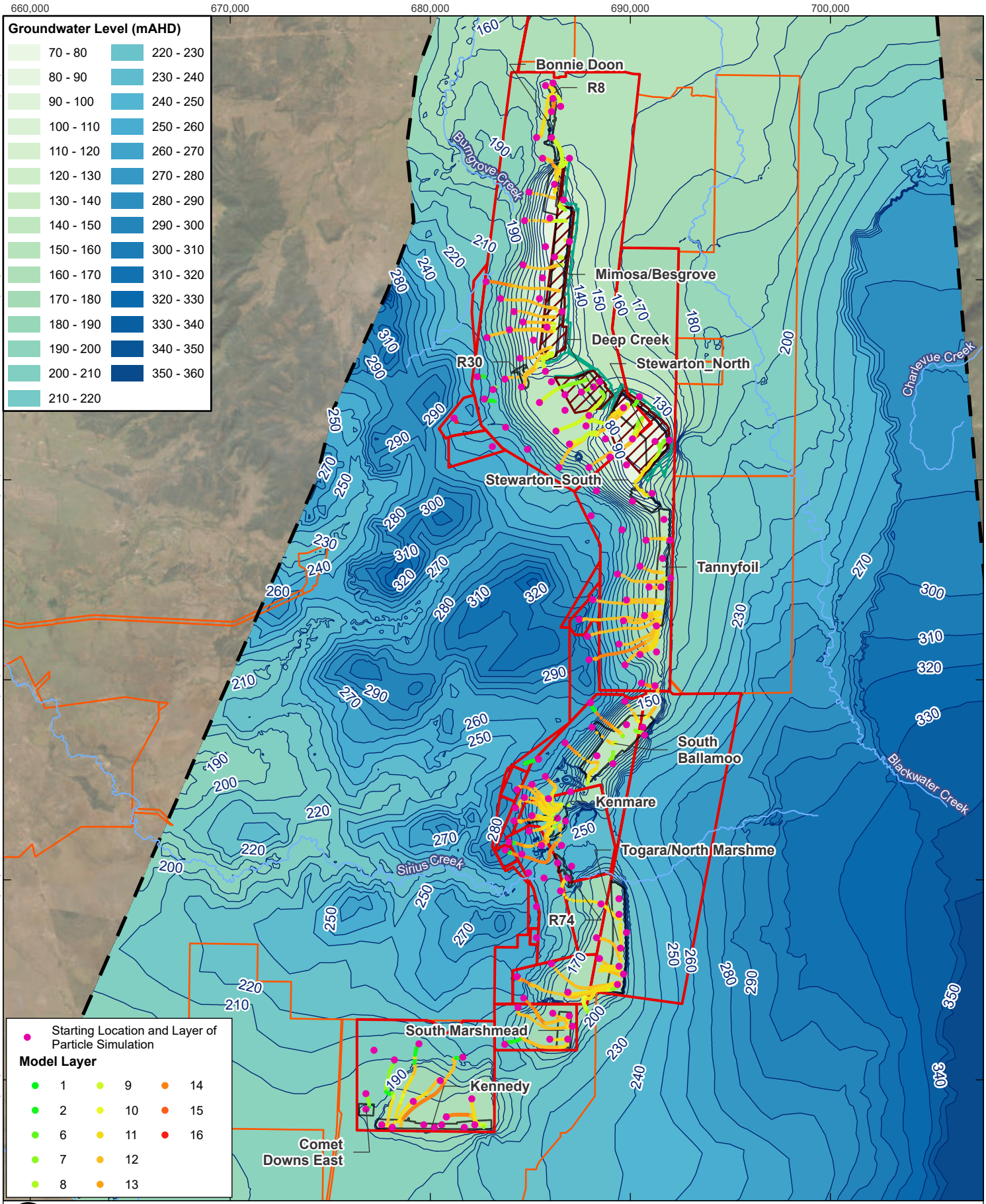
STARTING LOCATION OF PARTICLES

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE 5-10

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F05_09_Particle Starting Location



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	17-Feb-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Level (mAHD)
- BWM Mining Lease
- Mining Lease
- Study Area
- Void Extent
- BWM North Extension Project Area
- BWM North Extension Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

PREDICTED MOVEMENT OF PARTICLES – POST MINING (2093 – 4040)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE 5-11

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F05_10_Predicted Movement of Particles

6.0 Sensitivity Analysis

6.1 Purpose

Quantifying the sensitivity of both calibration performance and model predictions to input parameters provides critical insight into model behaviour and uncertainty. The combined sensitivity analysis presented in this section supports two primary objectives:

1 **Assessing parameter conditioning through calibration sensitivity**: Parameters that have a strong influence on calibration performance metrics are more likely to be conditioned by the calibration process. In contrast, parameters with low sensitivity to calibration performance are less likely to be conditioned by the calibration process, meaning that their posterior distributions will likely remain broad regardless of the amount or quality of calibration data.

2 **Understanding prediction sensitivity to parameter uncertainty**: When model predictions are highly sensitive to specific parameters, it indicates that uncertainties in those parameters have a strong influence on predictive outcomes. Conversely, if predictions are insensitive to a given parameter, then uncertainty in that parameter has limited influence on the modelled forecast.

Comparing calibration and predictive sensitivity allows for distinguishing between parameters that are constrained during calibration, and parameters that drive predictive uncertainty, which may or may not overlap. Such insights support decision-making in model refinement, data collection prioritisation and risk-based scenario analysis.

6.2 Methodology

To evaluate how variations in model parameters affect calibration and prediction outcomes, SLR employed two complementary global sensitivity analysis methods:

- Spearman rank correlation; and
- standardised linear regression coefficients.

These two methods assess different aspects of the input-output relationship and are well-suited to the often non-linear and complex behaviour of hydrogeological systems. They are commonly used in hydrological and environmental modelling due to their simplicity, interpretability and relatively low computational demand (Saltelli et al., 2008; Pianosi et al., 2016).

6.2.1 Data Aggregation and Standardisation

Pilot points were excluded from the sensitivity analysis to reduce parameter dimensionality since they are highly spatially correlated parameters, which can obscure the identification of key model controls and violate assumptions of parameter independence. The analysis therefore focused on primary hydrogeological parameters to better represent conceptual model behaviour rather than calibration-specific detail.

Parameter and observation data were pre-processed and standardised. Parameters using a log normal distribution were converted to $\log_{10}$ values.

Calibration performance was assessed using Mean Residual for this analysis because it aligns more closely with linear regression interpretation than other statistics that use squaring or absolute functions that change the linear relationship of parameter changes and calibration metrics.

For predictive sensitivity, predictive data included four groups: total alluvium take, total area with drawdown > 1 m, mine groundwater inflow (active mining) and total river take.



Parameter values (one group), calibration data (two groups) and prediction data (four groups) were standardised (zero mean, unit variance) independently (i.e. per group) to enable consistent comparison across variables and groups.

6.2.2 Spearman Rank Correlation Coefficient

Spearman rank correlation measures the monotonic relationship between input parameters and model outputs. It identifies whether changes in a parameter consistently increase or decrease a model output, regardless of the exact functional form of the relationship. This is especially useful in groundwater models where non-linearities are common due to boundary conditions, storage terms or non-linear recharge responses (van Griensven et al., 2006).

Given a parameter vector X and a model response vector Y, Spearman's rank correlation coefficient ρ is calculated as:

$$\rho = 1 - \frac{6\sum_{i=1}^{n}(R_i - S_i)^2}{n(n^2-1)}$$

where: R_i = rank of parameter X for sample *i*

S_i = rank of the corresponding model output Y

N = number of realisations

6.2.3 Linear Regression Sensitivity Coefficient

Linear regression sensitivity quantifies how much the output changes *on average* with a unit change in a parameter, assuming a linear relationship. It describes the *magnitude* of influence a parameter has on model outputs under the assumption of a linear relationship.

The relationship is represented as:

$$Y = X\beta + \epsilon$$

where: Y = model output

X = a matrix of standardized parameter values

β = vector of estimated sensitivity coefficients

ϵ = model error

The coefficient β represents the average change in model output (Y) for a one standard deviation change in model parameter (X) and is interpreted as a direct measure of sensitivity magnitude, specifically how the variance of the parameter uncertainty contributes to the variance of the predictive or calibration uncertainty. This method assumes linearity and additivity but remains useful as a first-order sensitivity metric (Helton et al., 2006).

6.2.4 Interpretation

There is no single universally accepted threshold for Spearman or regression coefficients in sensitivity analysis. However, some thresholds are often used as pragmatic benchmarks based on the practical significance of parameter influence rather than strict statistical cutoffs. For this analysis, moderate sensitivity was selected for an absolute ρ score > 0.2 and for an absolute β value > 0.1.

This dual-method framework supports robust sensitivity diagnostics by capturing both the consistency and strength of parameter influence. The combined use of both metrics enables us to distinguish between parameters that:

- have a strong and consistent effect;
- have an effect only in a narrow range (local sensitivity); and/or



- behave non-monotonically and inconsistently.

A comparison of the interpretive value of each method is provided in **Table 6-1**.

Table 6-1 Comparison of Spearman and Regression in Sensitivity Analysis

Sensitivity Scenario (S)	Impact of Parameter Changes on Model Outcome	Spearman	Regression	Interpretation
S1	Strong, consistent linear effect	> 0.2	> 0.1	Parameter is influential and predictable
S2	Consistent but nonlinear effect	> 0.2	< 0.1	Parameter is influential but not well described by linear models
S3	Local or inconsistent effect	< 0.2	> 0.1	Large effect in a narrow range
S4	Non-influential	< 0.2	< 0.1	Parameter has minimal influence

6.3 Results

The results are presented as bar charts in **Appendix E** and discussed in **Section 6.3.1** and **Section 6.3.2** for both Spearman rank correlation coefficient and Linear regression sensitivity coefficient.

6.3.1 Calibration Sensitivity (Parameter Conditioning)

Parameter with a ρ score > 0.2 and/or a β value > 0.1 (scenarios S1, S2 or S3 in **Table 6-1**) are likely to be conditioned through the calibration process.

As presented on **Appendix E** the calibration process is likely to be conditioning:

- Horizontal hydraulic conductivity (Kx) of the Clematis Group, Rewan formation (upper and middle), interburden, Pollux seam (lower) and tailings; as well as spatial locations associated with pilot points.
- Vertical hydraulic conductivity (Kz) of the interburden and tailings; as well as spatial locations associated with pilot points.
- Specific yield (Sy) of the Rewan Formation (upper); as well as spatial locations associated with pilot points.
- Riverbed Kz (Riv_vk) of the Humboldt Creek and tributaries.
- ET coefficient (evt) for the spoil and depth (exdp) for the alluvium.

The calibration process in unlikely to be conditioning the majority of:

- Recharge coefficients (rch).
- ET coefficient and depth (evt and exdp).
- Spoil hydraulic properties (spl_kx, spl_kz, spl_ss and spl_sy).

6.3.2 Predictive Sensitivity

Parameters with a ρ score > 0.2 and/or a β value > 0.1 (scenarios S1, S2 or S3 in **Table 6-1**) are likely to influence model predictions.



As presented in **Appendix E,** these parameters are:

- **For Mine associated drawdown:** Horizontal hydraulic conductivity of the regolith, Rewan formation (lower, middle and upper) and interburden; vertical hydraulic conductivity of the coal seams (lower); storage of the Rewan Formation (upper), interburden, coal seams, and spoil; recharge over the alluvium, regolith and weathered Clematis zones and spoil; ET rate and depth for the alluvium and regolith.
- **For Mine groundwater inflow (active mining):** Horizontal hydraulic conductivity of the regolith and Burngrove formation; vertical hydraulic conductivity of the coal seams, Burngrove formation and spoil; storage of regolith, Rewan formation, underburden and spoil; recharge over the weathered Clematis and weathered Permian zone, riverbed conductance of the Rockland Creek and tributaries.
- **For alluvium take:** Horizontal hydraulic conductivity of the alluvium, regolith, Clematis, Rewan formation (upper), overburden, interburden, underburden, Burngrove formation and spoil; vertical hydraulic conductivity of interburden, interburden, and Burngrove formation; storage of regolith, Clematis, overburden, interburden, coal seams, Burngrove formation, and spoil; recharge over the alluvium, regolith, and weathered Permian zones; ET depth for the alluvium, regolith, weathered Clematis and weathered Permian zones.
- **For River take:** Horizontal hydraulic conductivity of the alluvium, regolith, Rewan formation (upper and lower), overburden, interburden, Castor coal seam, and Burngrove formation; vertical hydraulic conductivity of the Rewan formation (middle and lower), interburden, coal seams, underburden and Burngrove formation; storage of regolith, Rewan formation, overburden, coal seams, underburden and spoil; recharge over the regolith and weathered Permian zones; ET depth for the alluvium; riverbed conductance of the Blackwater main stream and small streams.

6.3.3 Type I-IV Analysis

The Murray Darling Basin Commission (MDBC) Groundwater Flow Modelling Guideline (MDBC, 2001) recommends classifying sensitivity by the resultant changes (or contribution) to the model calibration and predictions. According to this process models can be classified as one of the four main types:

- Type I: Insignificant changes to calibration (low calibration sensitivity) and prediction (low predictive sensitivity).
- Type II: Significant changes to calibration (high calibration sensitivity) – insignificant changes to predictions (low predictive sensitivity).
- Type III: Significant changes to calibration (high calibration sensitivity) – significant changes to predictions (high predictive sensitivity).
- Type IV: Insignificant changes to calibration (low calibration sensitivity) – significant changes to predictions (high predictive sensitivity).

Types I-III are of less concern, as these Types have an insignificant impact on model predictions or conditioned by calibration. Type IV is classed as ‘a cause for concern’ as non-uniqueness in a model input might allow a range of valid calibrations but the choice of value impacts significantly on a prediction (MDBC, 2001).

To classify the sensitivity contribution to the model calibration and predictions for each model parameter, the calibration and prediction sensitivities were compared against each other for each parameter.



To allow comparing calibration and prediction sensitivity in one graph, a combined sensitivity value was calculated for each sensitivity group as:

$$Combined_{(i,g)} = 0.5 * | \beta_{(i,g)} | + 0.5 * | \rho_{(i,g)} |$$

where: $\beta_{(i,g)}$ = standardised regression coefficient for parameter *i* and group *g*.

$\rho_{(i,g)}$ = Spearman rank correlation coefficient between parameter and group *g*.

For this analysis, the threshold value for a sensitive parameter was set at 0.15, as the average of the threshold for *β and ρ* (see **Section 6.2.4**).

Comparison plots are presented for the alluvium take (**Figure 6-1**), drawdown (**Figure 6-2**) and mine groundwater inflow (active mining) (**Figure 6-3**), and Isaac River take (**Figure 6-4**). Type IV parameters are summarised in **Table 6-2.**

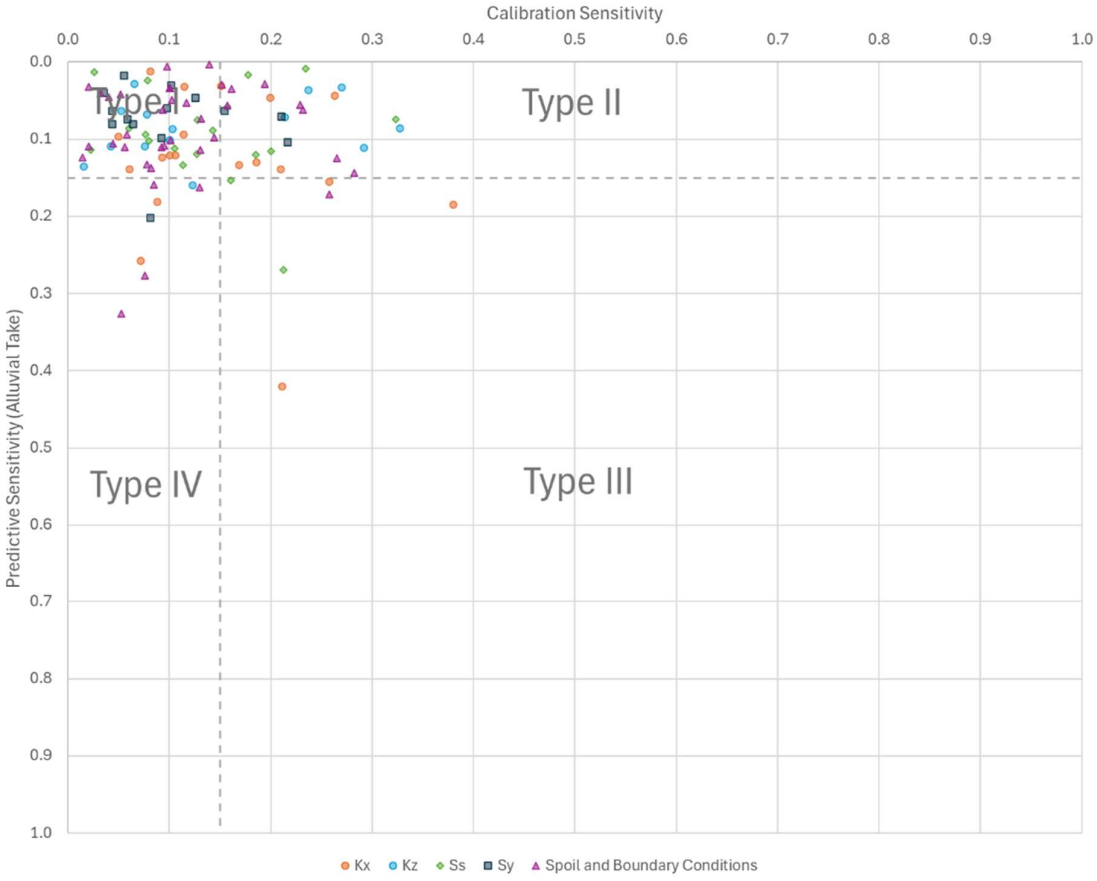


Figure 6-1 Predictive Sensitivity (Alluvium Take) Versus Calibration Sensitivity

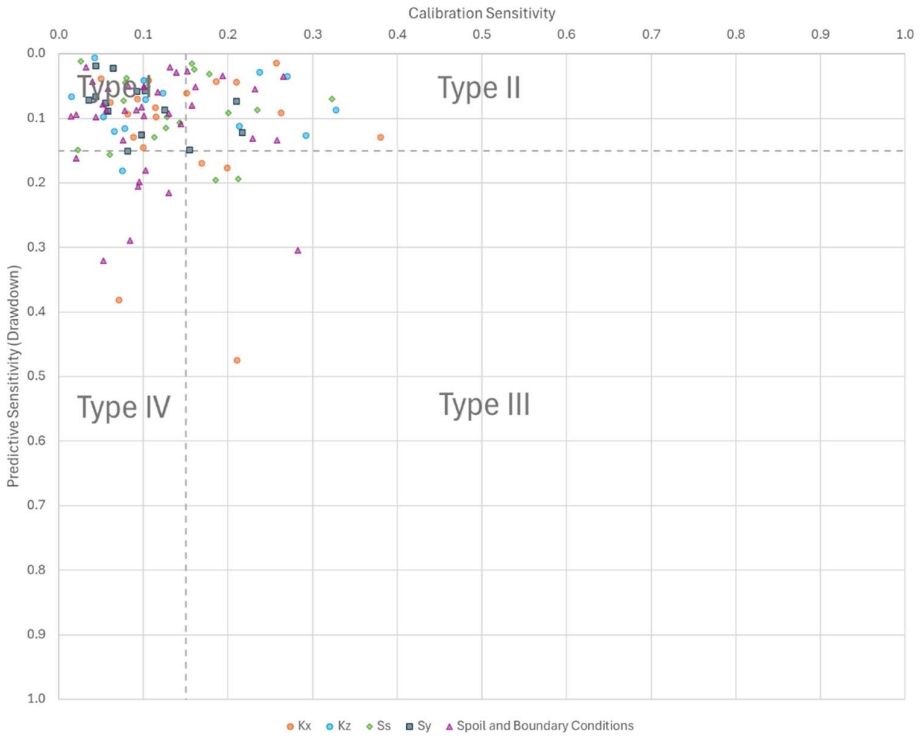


Figure 6-2 Predictive Sensitivity (Drawdown) Versus Calibration Sensitivity

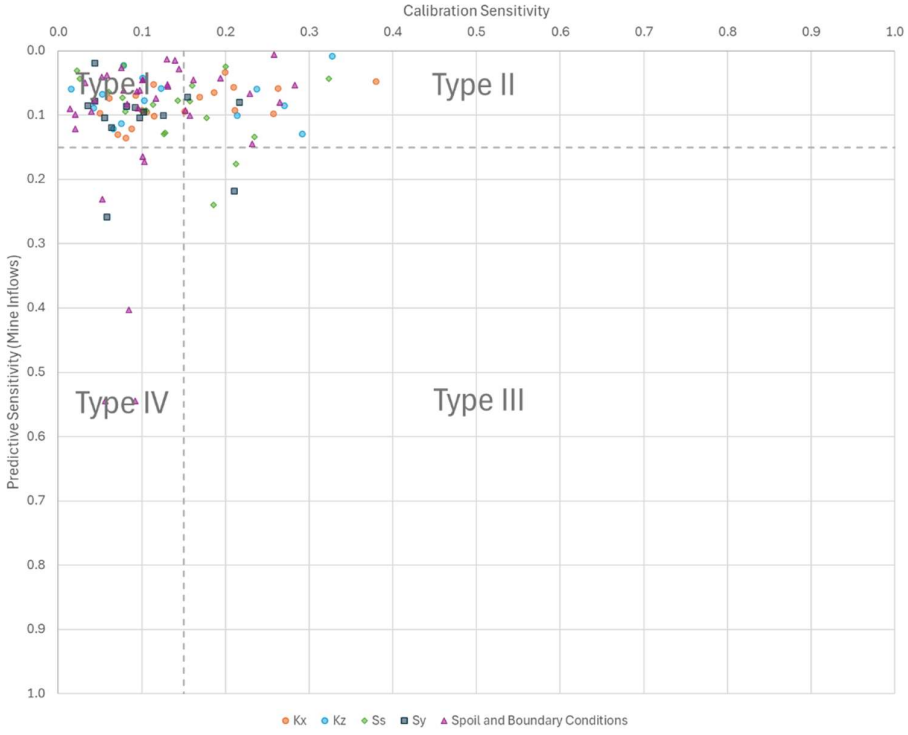


Figure 6-3 Predictive Sensitivity (Mine Inflow) Versus Calibration Sensitivity

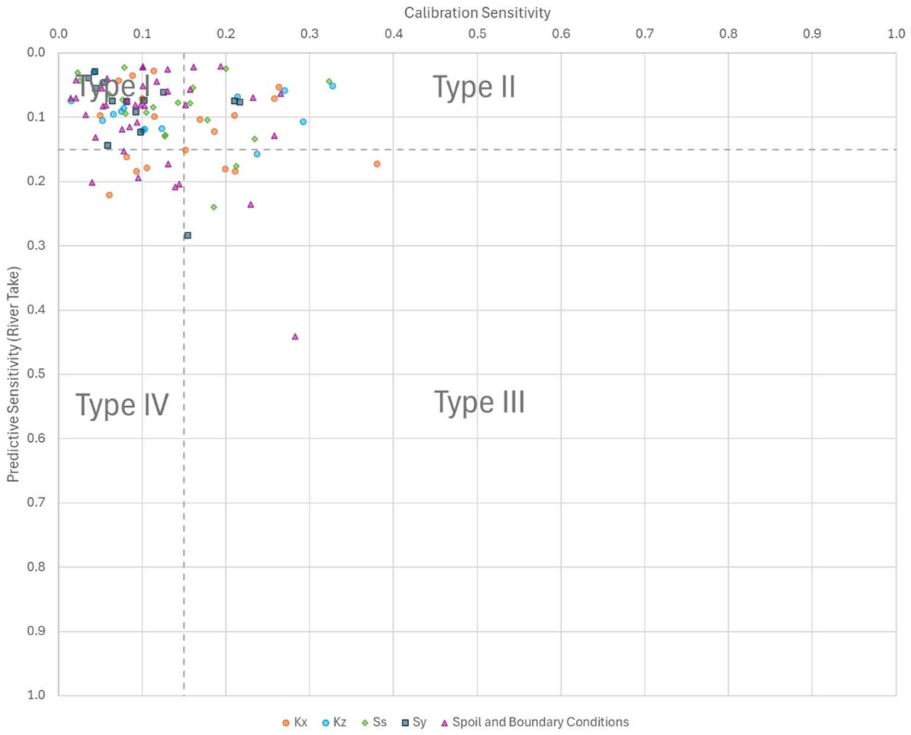


Figure 6-4 Predictive Sensitivity (River Take) Versus Calibration Sensitivity

Table 6-2 Type IV Parameters

Parameter	Description	Associated Prediction
kx_z04	Weathered zone	Alluvium Take, Drawdown
kzf_z18	Burngrove formation	Drawdown
rchf_z03	Weathered Clematis	Drawdown, Mine Inflow
rchf_z04	Weathered Permian	Alluvium Take, Drawdown, Mine Inflow
rivk_z02	Blackwater tributaries	Drawdown
rivk_z10	Tanny Foil dam	Drawdown
spl_rchf_z01	Spoil	Alluvium Take, Drawdown
spl_sy_z01	Spoil	Alluvium Take, Drawdown, Mine Inflow
ss_z02	Tertiary	Drawdown
sy_z13	Interburden	Alluvium Take, Drawdown
tl_rchf_z01	Tailing	Drawdown, River Take
exdp_z02	Regolith	Alluvium Take
kx_z18	Burngrove formation	Alluvium Take
kzf_z15	Interburden	Alluvium Take
rivk_z04	Rockland Creek and tributories	Mine Inflow
spl_kx_z01	Spoil	Mine Inflow
spl_kz_z01	Spoil	Mine Inflow
evtf_z02	Regolith	River Take
kx_z02	Tertiary	River Take
kx_z03	Alluvium	River Take

Parameter	Description	Associated Prediction
kx_z11	Interburden	River Take
kx_z19	Fair Hill formation	River Take
rchf_z02	Regolith	River Take
rivk_z01	Blackwater mainstream	River Take
rivk_z07	Small streams	River Take
spl_ss_z01	Spoil	River Take
ss_z04	Weathered zone	River Take
ss_z08	Rewan lower	River Take
ss_z10	Aries seam	River Take
sy_z09	Overburden	River Take

6.3.4 Conclusion

The sensitivity analysis suggests that most parameters in the model are adequately constrained by the calibration process. It also highlighted several parameters that contribute to predictive uncertainty and that are less conditioned by the calibration process (Type IV parameters).



6.4 Mine Inflows

Following peer review, it was noted that the modelled inflows (**Section 4.5**) were higher than observed pit inflows. These observations were typically 2.25 ML/day (Engeny Australia Pty Ltd, 2025), which are lower than the average cumulative mine inflow rate (2025 to 2093) of 5,139 ML/year (14.1 ML/day) (**Section 4.5**).

The peer reviewer requested that a couple of sensitivity simulations be conducted to test the sensitivity of the predicted mine inflows to the timing setup of when TVM activates the changes in parameters from host material properties to post-mining properties (i.e. spoil or void).

The model results presented outside this section use what will be referred to herein in the sensitivity assessment as the TVM3 setup. The TVM3 setup has hydraulic conductivity (Kx and Kz) change within the stress period when mining (DRN) is activated, and storage properties are activated in the stress period when DRNs become inactive.

MODFLOW USG does not instantaneously change parameter values at the beginning of the activated stress period. Instead, it either linearly or on a log transform basis changes the parameters over the stress period length such that only at the end of the stress period is the full change implemented. An example for how TVM3 is implemented would be:

- Assume a mining DRN cell becomes active in stress period 50 and is active for 1 stress period (i.e. is inactive in stress period 51).
- Hydraulic conductivity values would be transformed (SLR uses the log transform option) over the duration of stress period 50 such that by the end of mining the hydraulic properties would be equal to the spoil properties and therefore full spoil properties for the beginning of stress period 51 when DRNs are inactive.
- Storage properties would not begin to change until stress period 51 and would be fully transformed by the end of stress period 51, one year after mining was completed.

The peer reviewer requested two sensitivity simulations that vary the start timing of the TVM operations.

- TVM2 – this option has all parameters begin to change in the stress period following the mining. In the above example, this would mean no change to how storage was handled but would push the change of hydraulic conductivity values to begin the stress period after mining has ceased (stress period 51) with full implementation of the changes by the end of stress period 51.
- TVM1 - this option has all parameters begin to change in the stress period when the mining is activated. In the above example, this would mean no change to how hydraulic conductivities were handled but would push the change of storage values to begin the stress period when mining commences (stress period 50) with full implementation of the changes by the end of stress period 50.

The results for estimated total pit inflows are provided for TVM2 and TVM3 in **Figure 6-5**. The results for TVM1 were exactly the same as those for TVM3 and therefore are not explicitly represented in **Figure 6-5**.

The predicted mine inflows are insensitive to the timing of when storage properties are changed.

The predicted mine inflows are sensitive to the timing of when hydraulic conductivity properties are changed. By delaying when the hydraulic properties are changed to the year after mining was completed reduces predicted pit inflows. The reduction in inflows is closer to the observed values; however, it is noted that neither model result has been corrected for



evaporation that would occur on the highwalls and pit floors, and as such would be expected to be greater than observed ingress and or values estimated from operational site water balance models.

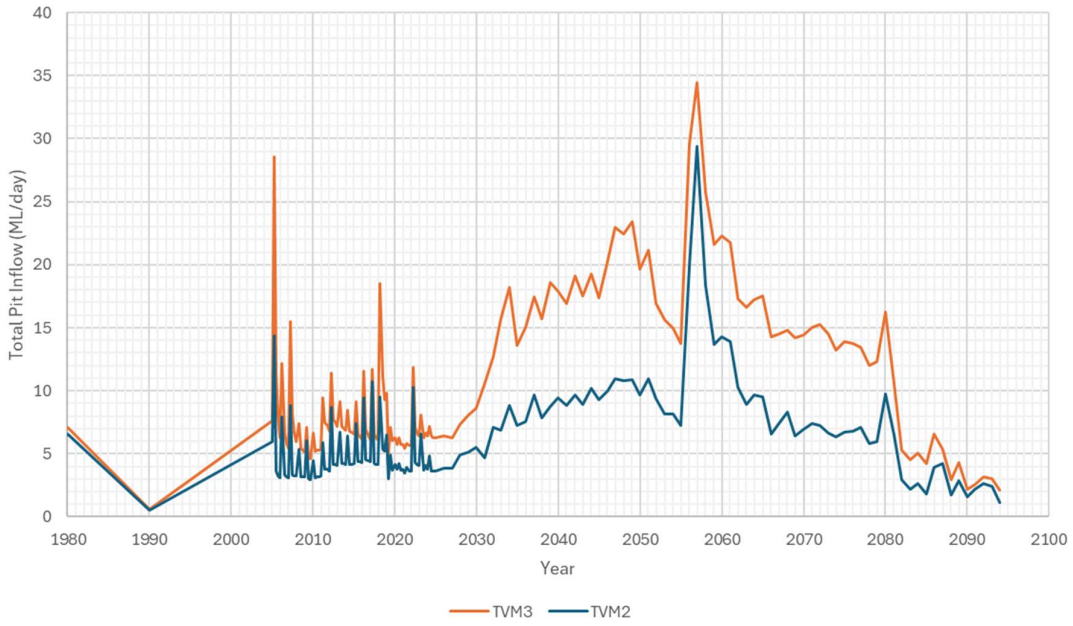


Figure 6-5 TVM Sensitivity Analysis – Predicted Cumulative Mine Inflows

7.0 Uncertainty Analysis

A Type 3 Monte Carlo uncertainty analysis was undertaken to estimate the uncertainty in the future impacts predicted by the model. This method operates by generating numerous alternative sets of input parameters to the deterministic groundwater flow model (realisations), executing the model independently for each realisation, and then aggregating the results for statistical analysis. This approach is consistent with guidance provided by the Independent Expert Scientific Committee (IESC) (2018) for uncertainty analysis within a groundwater modelling risk management framework.

The first step in Monte Carlo analysis is to define the parameter distribution and range. For this project, the software PESTPP-IES (part of the PEST suite) was used to generate parameter ensembles based on a provided range of plausible value. The parameter distributions for the sampled prior and the calibrated ensemble are shown in **Appendix F**.

PESTPP-IES uses an “ensemble smoother” method that enable optimising each realisation in order to obtain an ensemble (suite of realisations) that:

- covers the range of plausible parameters distribution; and
- is calibrated to historical water level data.

As discussed in **Section 3.1**, a total of 75 calibrated realisations were selected from the last iteration and regarded as sufficient.

The predictions included in the uncertainty analysis were:

- maximum drawdown;
- predicted open cut mine inflow;
- alluvium water take; and
- change in river baseflow.

7.1 Uncertainty Convergence

SLR conducted statistical analyses of predictive results to assess if additional realisations were likely to provide results that would significantly change reported results. SLR calculated the 95% confidence interval for the predictive results.

The confidence intervals are presented sequentially as more realisations are added. For example, the confidence interval of the predicted alluvium take and total dewatering rates was calculated using the results from two realisations, three realisations, sequentially up to the total number of realisations.

Figure 7-1 and **Figure 7-2** show the median and maximum confidence intervals of alluvium take and total dewatering rates respectively, as well as the variance of the confidence intervals as more realisations are added. To calculate the statistics shown, the following steps are taken:

1 The model results of interest, total dewatering rates for this example, are first processed for all realisations.

2 The 95% confidence interval is then calculated sequentially as more realisations (i.e. results) are added, creating a sequential progression of confidence intervals as new realisations are added.

3 Median and maximum values of confidence intervals are then calculated at each interval of realisations being added.

4 Variance is calculated from the confidence intervals at each interval of realisations being added.

As indicated in **Figure 7-1** and **Figure 7-2**, additional realisations are unlikely to significantly increase or decrease the confidence intervals of predictions. This conclusion is drawn based upon the combination of two factors:

1 The rate of change per additional realisation is small.

2 The magnitudes of the confidence interval are small and well below reasonable expectation of the predictive ability of a numerical model.



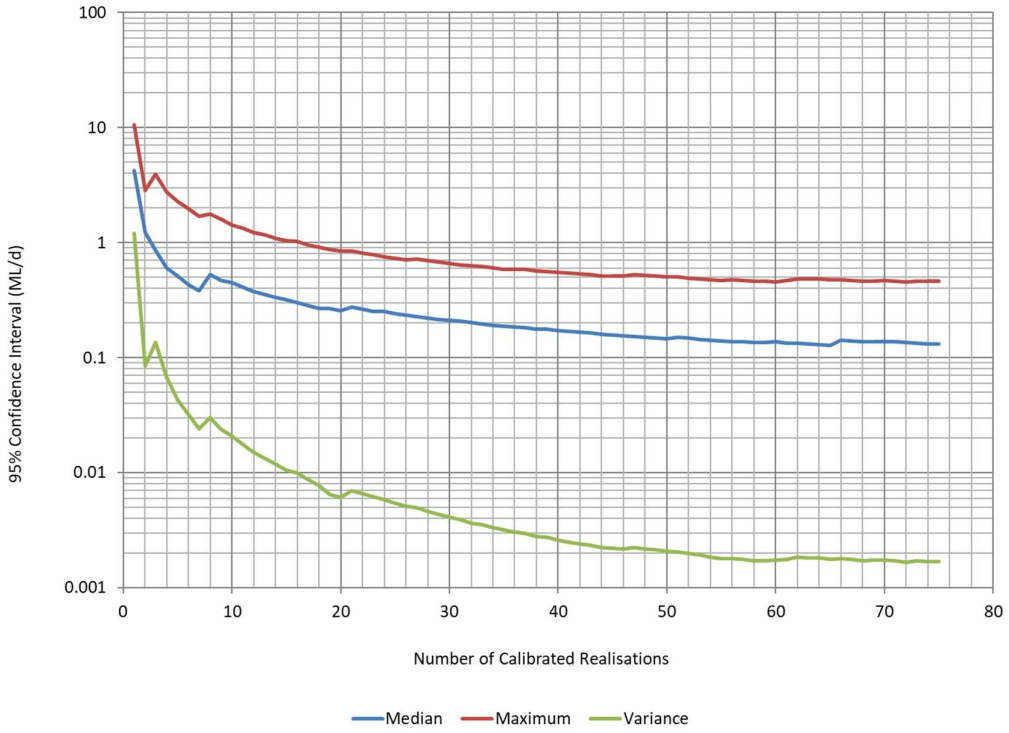


Figure 7-1 Predictive Uncertainty Convergence – Alluvium Take

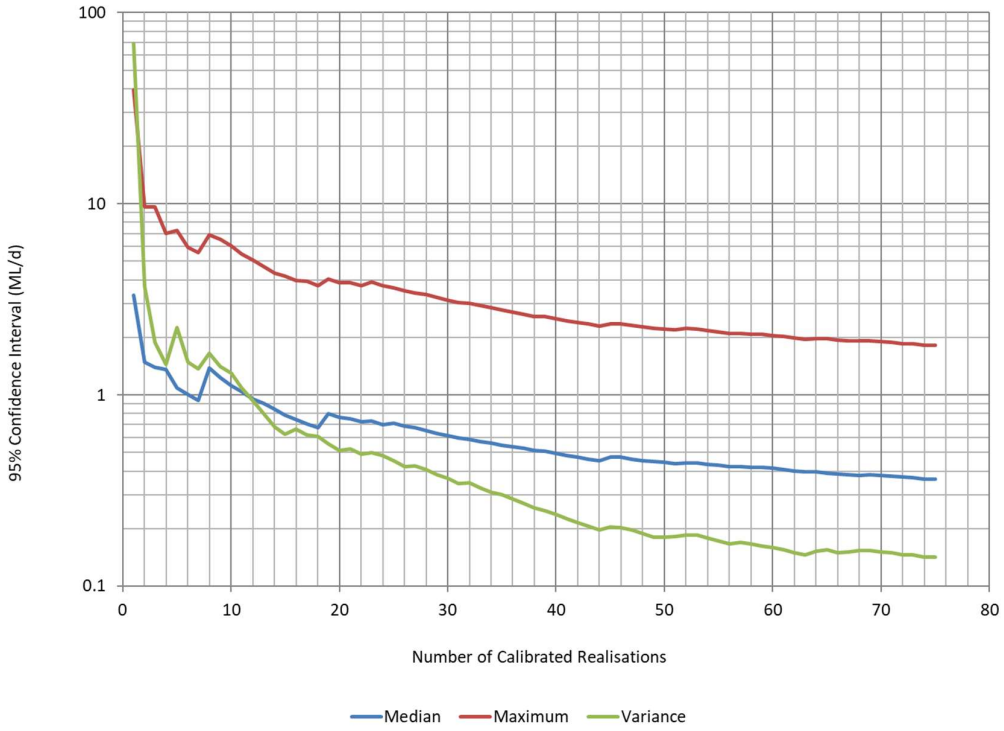


Figure 7-2 Predictive Uncertainty Convergence – Dewatering Rate

The “converged” values shown in **Figure 7-1** to **Figure 7-2** for alluvium take and total dewatering rate do not represent physical dewatering or water take rates at a specific point in time. Instead, they reflect the reduction in predictive uncertainty as more realizations are included. In other words, convergence indicates that additional realizations do not significantly change the spread of model predictions. Therefore, this value is a statistical measure of prediction stability rather than an actual pumping rate.

7.2 Uncertainty Results

7.2.1 Uncertainty in Mine Inflows

The uncertainty in groundwater inflow into the open cut mine (active take) from the start of the predictive model (2025) to the end of mining (2093), is shown for the cumulative Scenario (**Figure 7-3**). The predicted inflows are shown for the BCM and different percentiles prediction ranges. These represent the:

- Minimum to 5th percentile indicates it is very likely the outcome is larger than this range.
- 5th – 33th indicates it is likely that the outcome is larger than this range.
- Median indicate it is as likely as not that the outcome is larger or smaller than this value.
- 33th - 67th indicates it is likely that the outcome is within that range.
- 67th – 95th indicates it is unlikely that the outcome is larger than this range.
- 95th percentile indicates it is very unlikely the outcome is larger than this value.

Overall, the results indicate that the BCM is representative of the median estimated mine inflows. From 2056, the BCM is more representative of the 67th to 95th percentile band.

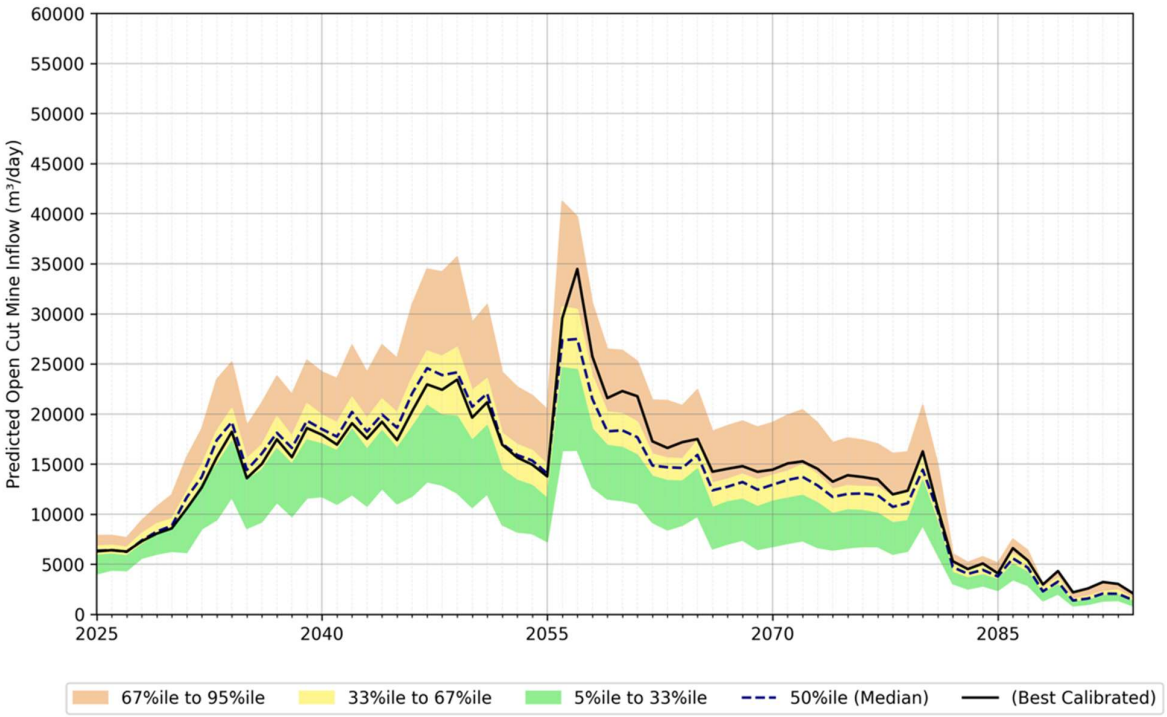


Figure 7-3 Predicted Open Cut Inflow Uncertainty - Cumulative Scenario

7.2.2 Uncertainty in Alluvium Take

The uncertainty in alluvium take for the alluvium associated with the Blackwater Creek is shown for the incremental scenario (**Figure 7-4**) and the cumulative scenario (**Figure 7-5**). Negative values indicate a reduction in alluvium take while positive values indicate an increase in alluvium take.

The BCM is representative of the median for the incremental alluvium take and the 5th to 33th percentile for the cumulative alluvium take.

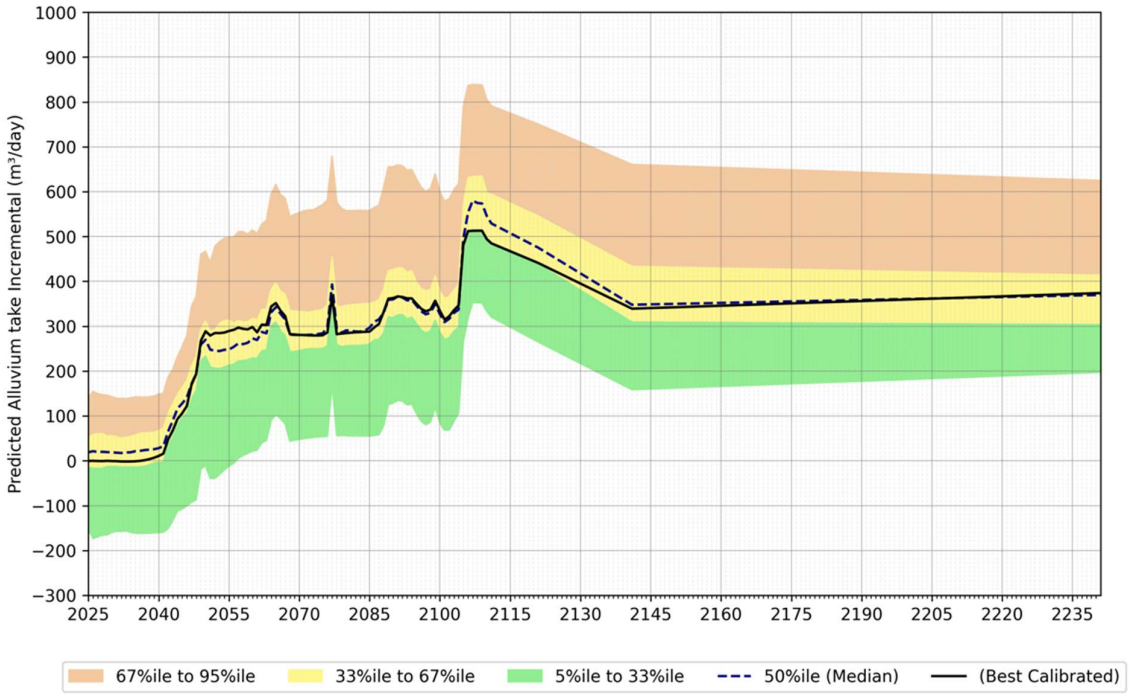


Figure 7-4 Uncertainty in Incremental Alluvium Take

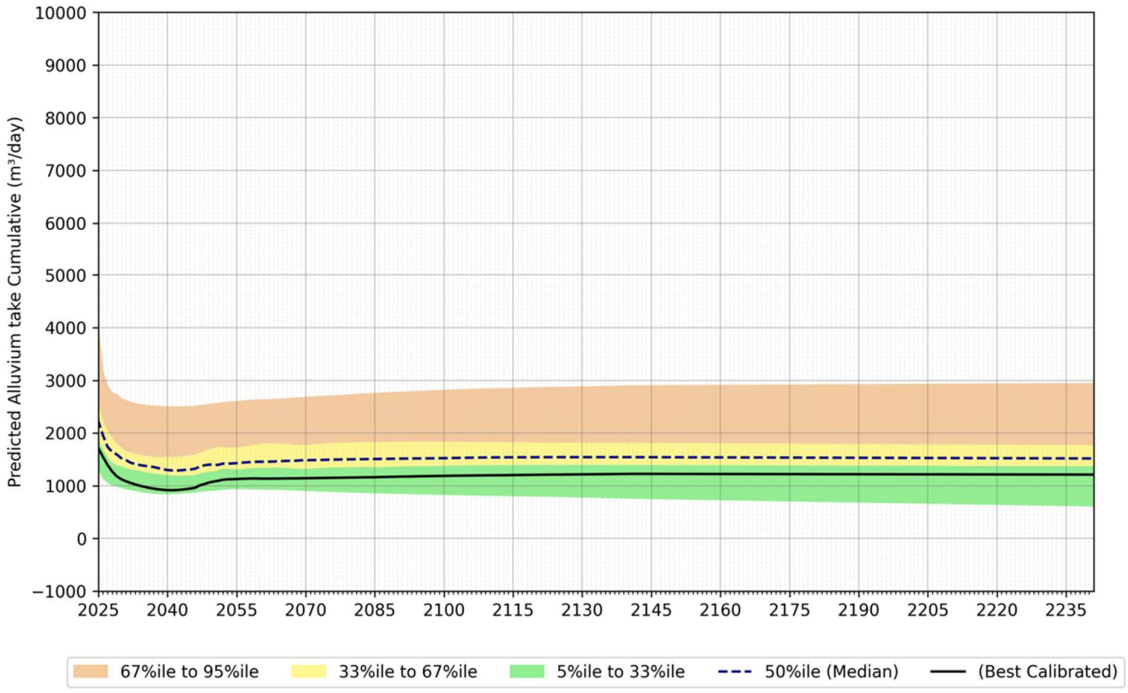


Figure 7-5 Uncertainty in Cumulative Alluvium Take

7.2.3 Uncertainty on Surface Water Flow

The change in groundwater flow to Blackwater Creek due to the Project was calculated by comparing the river flow budgets for Blackwater Creek in the Cumulative scenario against the Approved scenario.

The uncertainty in change in groundwater flow to Blackwater Creek is shown for the incremental scenario on **Figure 7-6**. Negative values indicate an increase in groundwater fluxes to Blackwater Creek while positive values indicate a decrease in groundwater fluxes to Blackwater Creek. The BCM is representative of the median.

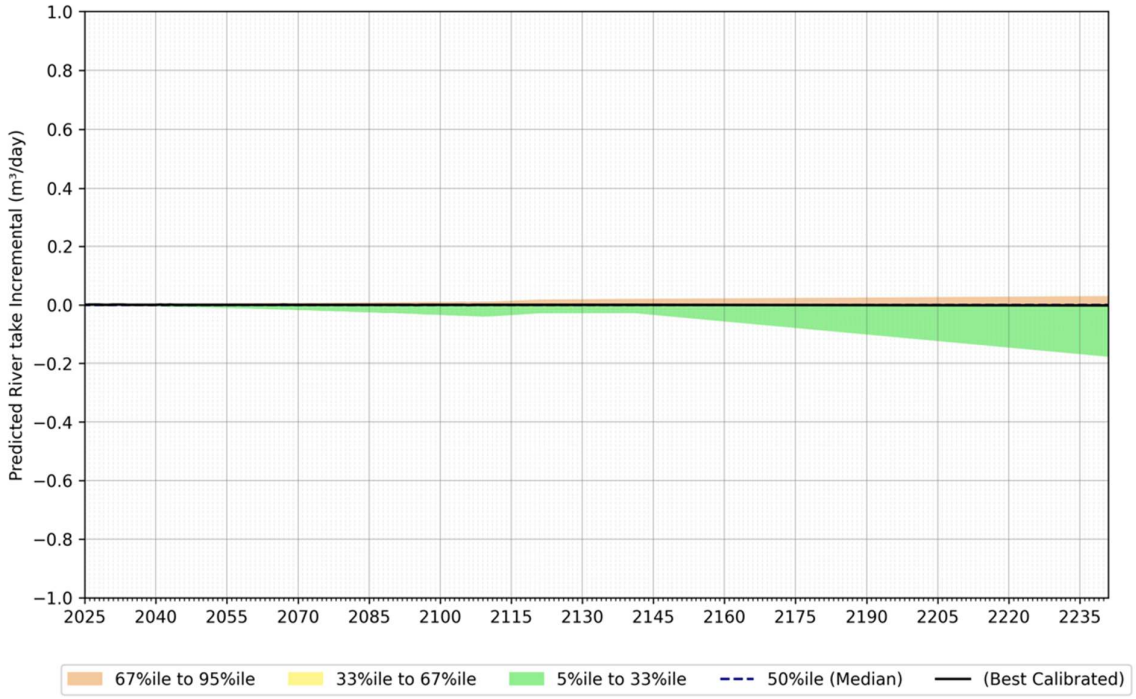


Figure 7-6 Uncertainty in Incremental River Baseflow Loss

7.2.4 Uncertainty in Drawdown

To illustrate the level of uncertainty in the extent of predicted mine induced drawdown (1 m contours), the 50th percentile maximum drawdown extent were compared to the maximum drawdown extent for the 5th and 95th percentiles (**Appendix G**). Both cumulative and incremental drawdown were calculated to demonstrate the impacts of mining on groundwater levels across different model layers. Incremental drawdown is generally limited in extent within model layers 1 and 2; however, the 95th percentile drawdown extent expands to the model boundary in the deeper layers.

8.0 Model Confidence and Limitations

The groundwater modelling was conducted in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012), the MDBC Groundwater Flow Modelling Guideline (MDBC, 2001) and the IESC Explanatory Note for Uncertainty Analysis (Peeters and Middlemis, 2023).

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

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

- **Usable:** Relevant to the decision-making process, providing information about the uncertainty in conceptualisations and modelling simulations in a way that allows decision-makers to understand the effects of uncertainty on project objectives and the effects of potential bias. The relevant QoIs in this context are the groundwater inflows (active mining and final voids), drawdown due to mining and fluxes changes due to mining.
- **Reliable:** Demonstrate that the range of model outcomes is consistent with the system knowledge and honours historical observations, and provides objective evidence that uncertainties affecting decision-critical predictions of impacts on aquifer resources and dependent systems are not underestimated. The calibration performance was deemed acceptable, and a rigorous uncertainty analysis was undertaken to further improve confidence in the modelling outputs.
- **Feasible:** Trade-offs due to budget, time and technical constraints are reasonable and justifiable within the risk context of the project. This study is an update of a 2021 model variation, which shows that there are several model revisions and the latest data has been included. The model has been peer reviewed for each revision. This model build and associated review process is deemed commensurate with the Project related risk to the groundwater environment.

In order to assess these three points above, the four sources of scientific uncertainty (structural, parametrisation, measurement error, predictions) have been qualitatively assessed with regards key aspects of the BWM groundwater model, as presented in **Table 8-1**.

Overall, the model captures depressurisation due to active mining. The model is numerically stable with an acceptable mass balance error. The model shows a good fit between observed and modelled groundwater levels. A depth dependence function was used for hydraulic conductivity. Overall, the model is considered fit for purpose to achieve the objectives outlined in **Section 1** based on the data provided and the Project timeframe. Updates could be conducted in future to further refine the model, but this would be dependent on the purpose of the modelling and availability of data to inform future changes.

The model sensitivity was explored for an array of parameters. This showed that these parameters were generally well constrained by the calibration. Parameters are likely to contribute the most to predictive uncertainty (Type IV) were also identified.

The uncertainty analysis was undertaken to add a likelihood estimate to the prediction for the quantities of interest.



Table 8-1 Groundwater Model and Data Limitations

Type	Part	Status	Comment
Structural/ Conceptual	Grid and Model Extent	Fit for purpose	The model has an unstructured Voronoi grid that includes detailed cell refinement around site, neighbouring mines and along drainage features.
	Layers	Fit for purpose	Top of layer 1 incorporates site Light Detection and Ranging data.
		Fit for purpose	Representation of alluvium based on the CSIRO Regolith mapping Wilford et al (2016) and refined based on site drill data.
	Conceptualisation – Geological Structure	Fit for purpose, future improvements possible where new data collected	The local structure of the geology is based on detailed data at site (BWM geology model), and regional model geometry (outside of site) interpolated based on publicly available data, such as geological mapping and the CSIRO Regolith data set. Geophysical surveys across the Project area have identified minor faulting in the BWM area. Faulting is typically confined to the coal seams of the RCM. The minor faults show a displacement of up to 5 m. Hence, no geological structures (i.e. faults) have been included within the Project area in the model other than through layer displacements from the site geological model. The main regional fault (shot over fault) was included as the eastern model boundary. Displacements of up to 3,000 m are reported at this fault. The Permian coal measures outcrop along the western edge of the site. Therefore, how this is captured within the model influences the model predictions. The structure of the coal seams was checked to ensure it matches observed and mapped geology. The predictions of drawdown adjacent to mining was checked and the model shows a good fit between modelled and observed trends.
	Conceptualisation – GDEs	Fit for purpose, future improvements possible	A GDE conceptualisation is provided in SLR (2026).
	Conceptualisation – Surface Water Groundwater Interactions	Fit for purpose	The groundwater - surface water interactions are conceptualised as limited. Due to the gauged creeks to be classified as ephemeral (SLR, 2026), no long-term baseflow contribution from the groundwater is expected. Rather, surface water is expected to recharge the groundwater and after such recharge events, some minor baseflow contributions back into the creeks is possible.



Type	Part	Status	Comment
	Conceptualisation – Saturated Extent of Alluvium and Regolith	Fit for purpose future improvements possible	Site monitoring network includes one bore mapped within alluvium that was used to inform saturated extent of alluvium locally at site and for calibration targets. However, the alluvium in the area was found dry at this location. Other attempts to drill into the alluvium were abandoned, as either no alluvium was found or the alluvium was dry, or the bores were installed into the Rewan instead. The modelled groundwater levels in alluvium have hence no comparison available.
Parameterisation	Hydraulic Conductivity – Shallow layers	Fit for purpose	Spatial variability of hydraulic parameters in the Alluvium and Regolith have been incorporated in this model version by adding pilot points in both layer 1 and 2. This enhancement has allowed representing the heterogeneity in the alluvial system, improving the model's ability to replicate water level measurements in these units.
	Hydraulic Conductivity – Depth Dependence	Fit for purpose	Field testing of hydraulic conductivity (horizontal and to a lesser extent vertical) has been conducted in the area. Hydraulic conductivity test results from the other sites within the model domain were also considered. The data shows a general decline in hydraulic conductivity with depth that is replicated in the model.
	Spoil Properties	Fit for purpose, future improvements possible	Limited site-specific data is available for the spoil. Spoil properties were adopted using the previous studies.
	Rivers	Fit for purpose, future improvements possible	Blackwater Creek stage height is changed temporally in the historical calibration model based on observed levels from site stream gauges, and long term annual average level assumed in the predictive model. Blackwater Creek records flow only for a few days per year. The simulation of river stage height involves representing it as the average stage over the entire model stress period. However, since the stress periods (i.e., time slices) in the model are quarterly or annual, the stage height for Blackwater Creek persists in the model for a much longer period than it does in reality. This conservative design approach results in the simulation of what is naturally an ephemeral river reach as a perennial river in the model. Consequently, this leads to an overprediction of water levels in the alluvium along Blackwater Creek. All other watercourses within and in the vicinity of the Project area are ephemeral and only flow briefly after rainfall. Therefore, river stage height of zero was assigned to these watercourses in the model.



Type	Part	Status	Comment
	Recharge	Fit for purpose	Recharge zonation is based on mapped surface geology and calibrated recharge rates.
Measurement Error	Observation Data Quality	Fit for purpose	Bore logs and construction details available for most site bores, and long-term site water level data available for various units.
	Landholder Bore Data Quality	Fit for purpose, future improvements possible	Impacts on registered landholder bores are influenced by the assumptions of the bore design, target geology and use. Verification of landholder bore details may be required in future.
	Temporal spread	Fit for purpose	Timeseries water level data from the site as well as for the tertiary and Permian coal measures.
Scenario Uncertainties Future stresses/ conditions	Calibration	Fit for purpose	Transient warm-up (1970-2005) and transient (2005 to 2024) calibration model set up and a depth dependence function used and calibration to water levels conducted using automated (PEST) and manual methods.
	Predictive	Fit for purpose	Model captures approved and proposed open cut mining at BWM. The model also includes future mining at BWM South and Curragh mines, mainly based on publicly available data. The actual future mine progression for these sites may vary.
	Sensitivity and uncertainty	Fit for purpose	Uncertainty analysis has been conducted using PESTPP-IES. The uncertainty analysis quantified the variability in predictions with changes in maximum predicted drawdowns, mine inflows, impact on alluvium flow and impacts on surface water flow.



8.1 Conclusions

The numerical groundwater model developed for the Project successfully achieved the modelling objectives, as outlined in **Section 1**. Model calibration statistics are within suggested guidelines (Barnett et al., 2012) and mass balance errors remain low, through the model calibration and predictive modelling. Model construction considers all available data, including the current site mine plan and site geological model for the Project area. The uncertainty analysis has demonstrated a low likelihood for the Project to impact on alluvial water levels, with Project related drawdown primarily contained within the Project area. The model serves as a suitable representation of possible transient groundwater conditions within the Study Area, over the life of the Project, however, the uncertainty in predictions should be acknowledged.

Limited site-specific information on hydraulic conductivities and storage parameters were available during calibration. As more site-specific hydraulic data becomes available, new data should be compared with the calibrated parameters achieved and the validity of the model calibration should be assessed. Additional site-specific data is expected to “tighten” uncertainty bounds for model prediction results.

Predictive sensitivity indicates that mine inflows are sensitive to spoil hydraulic parameters. However, calibration sensitivity to these parameters is relatively low. Future work should consider opportunities to further constrain values of these parameters.



9.0 References

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Appendix A Calibration Residuals

Blackwater North Extension Project

Groundwater Modelling Technical Report

Whitehaven Blackwater Pty Ltd

SLR Project No.: 640.031809.00001

7 October 2026

ID	Easting	Northing	Layer	Average Residual	Min	Max
BG No.1 AP	684107	7387742	16	-6.37	-6.64	-6.21
BG No.2 BG	684414	7384622	16	0.77	-1.79	3.86
BWM_MB01_02	687411	7344932	10	-32.48	-33.38	-29.14
BWM_MB02_01	691791	7362760	7	4.28	3.43	4.73
BWM_MB02_02	691803	7362756	10	-19.82	-20.36	-19.34
BWM_MB03_02	692220	7381519	5	-9.80	-9.83	-9.74
BWM_MB04_01	686247	7350296	10	15.26	13.07	16.69
BWM_MB100_01	683897	7353255	2	10.95	10.95	10.95
BWM_MB106_01	684923	7352654	2	-3.17	-3.17	-3.17
BWM_MB107_04	685192	7352941	12	-17.47	-17.47	-17.47
BWM_MB108_04	685132	7353470	12	-21.74	-21.74	-21.74
BWM_MB109_02	684843	7353684	12	0.69	0.69	0.69
BWM_MB110_01	684722	7353488	11	-2.59	-2.59	-2.59
BWM_MB113_01	684003	7353042	2	1.37	1.37	1.37
BWM_MB114_01	683973	7352659	2	-2.47	-2.47	-2.47
BWM_MB116_02	683430	7351232	16	-7.23	-7.23	-7.23
BWM_MB117_01	683622	7350774	16	-4.44	-4.44	-4.44
BWM_MB117_02	683557	7350857	2	3.63	3.63	3.63
BWM_MB118_02	683708	7350621	16	-2.75	-2.75	-2.75
BWM_MB11_01_R01	691468	7360018	7	-27.53	-30.77	-24.28
BWM_MB11_02	691462	7360012	10	3.78	-2.49	10.05
BWM_MB11_03	691458	7360008	12	16.79	11.89	21.69
BWM_MB121_02	684196	7350960	16	16.79	16.79	16.79
BWM_MB122_01	684453	7351176	7	10.01	10.01	10.01
BWM_MB123_02	683946	7351056	16	6.89	6.89	6.89
BWM_MB126_02	684063	7351953	16	1.90	1.90	1.90
BWM_MB12_02	687969	7356097	10	-1.03	-1.81	-0.44
BWM_MB12_03	687977	7356091	12	-3.34	-3.38	-3.30
BWM_MB130_01	684963	7351640	7	-2.90	-2.90	-2.90
BWM_MB130_02	684959	7351646	12	1.77	1.77	1.77
BWM_MB131_02	684803	7351242	16	6.65	6.65	6.65
BWM_MB132_02	684591	7351283	16	4.75	4.75	4.75
BWM_MB134_02	684943	7351085	16	7.27	7.27	7.27
BWM_MB135_02	684899	7350805	14	-7.49	-7.49	-7.49
BWM_MB136_02	684603	7350311	16	-5.65	-5.65	-5.65



ID	Easting	Northing	Layer	Average Residual	Min	Max
BWM_MB137_02	685185	7350987	16	9.19	9.19	9.19
BWM_MB138_02	684736	7350972	13	2.42	2.42	2.42
BWM_MB15_01	686794	7347807	2	25.82	25.78	25.90
BWM_MB15_02	686779	7347804	12	-11.83	-17.56	-6.11
BWM_MB15_03	686768	7347802	10	-15.47	-19.04	-11.90
BWM_MB164_01	683816	7350493	2	4.01	4.01	4.01
BWM_MB16_01	682882	7340174	2	0.79	-0.11	1.25
BWM_MB16_02	682883	7340184	10	-9.65	-9.85	-9.31
BWM_MB16_03	682875	7340188	12	-8.73	-8.93	-8.35
BWM_MB17_02	684119	7343373	2	0.56	-1.34	0.92
BWM_MB17_03	684111	7343371	2	-7.25	-7.43	-6.95
BWM_MB19_01	683803	7350482	16	-17.23	-17.23	-17.23
BWM_MB21_02	686043	7342140	8	-22.34	-22.79	-21.89
BWM_MB21_03	686041	7342148	12	-22.97	-23.38	-22.60
BWM_MB22_01	687412	7344924	2	5.12	5.02	5.18
BWM_P4	684098	7352908	2	-2.13	-2.95	-1.12
BWM_P7	684002	7352973	2	-0.75	-1.03	-0.55
FY16_PZ_2	686714	7387555	12	-2.03	-2.78	-1.18
FY16_PZ_3	686322	7388372	12	-11.22	-12.19	-6.15
FY16_PZ_4	686206	7389577	12	-7.77	-8.13	-7.47
FY16_PZ_5	685482	7389168	12	-2.78	-3.12	-2.52
MB1	686528	7387172	8	-6.22	-10.85	-1.07
MB15	688772	7354180	7	0.31	-4.92	4.89
MB16	687966	7352289	7	-13.18	-25.78	4.22
MB17	691280	7370333	7	-11.70	-14.22	-10.07
MB18	691528	7370782	7	-7.71	-12.53	-3.55
MB19BWM01P	690024	7390277	8	-6.82	-7.22	-6.32
MB19BWM02A	690112	7390183	6	-0.60	-1.13	0.02
MB19BWM03P	688442	7383483	8	-7.40	-10.97	-3.31
MB19BWM04R	688307	7383595	6	-16.58	-17.11	-16.27
MB19BWM06P	687694	7379464	8	9.68	8.96	10.74
MB19BWM08P	691544	7370740	8	8.63	8.45	9.15
MB19BWM25P	689262	7376881	6	-5.66	-6.01	-5.16
MB19BWM27P	689070	7376739	8	1.30	0.98	1.71
MB19BWM_10P	684383	7342058	12	-13.09	-13.22	-12.97



ID	Easting	Northing	Layer	Average Residual	Min	Max
MB19BWM_15P	669194	7338140	8	-5.94	-7.40	-5.09
MB19BWM_16R	669188	7338156	6	-10.61	-12.19	-9.15
MB19BWM_18P	677019	7338061	8	-11.22	-13.01	-10.33
MB19BWM_24P	670211	7342228	8	-11.82	-11.95	-11.69
MB19BWM_25P_B	683532	7333206	8	3.15	3.04	3.34
MB20BWM02P2	686321	7388395	10	-15.11	-17.87	-5.71
MB20BWM03P1	686489	7387296	10	-12.75	-13.20	-12.53
MB20BWM03P2	686490	7387289	12	-10.62	-12.21	-9.73
MB23	683792	7350850	16	-0.59	-0.77	-0.36
MB3	688026	7373479	8	3.12	0.11	7.54
MB4	692072	7366435	7	-19.36	-20.81	-12.30
MB6	686881	7347723	7	25.74	20.88	30.20
MB8	681544	7373895	2	1.56	-0.75	4.19
MB9	682318	7372602	16	7.38	6.97	7.67
RGS_PZ2-3	683745	7351052	2	3.20	3.00	3.41
RGS_PZ6-2	683925	7350731	2	8.53	7.91	9.78
TMB1-D	681252	7372802	16	-0.02	-0.12	0.07
TMB1-S	681249	7372800	2	3.95	3.82	4.05
TMB5-S	683230	7373039	2	11.23	10.85	11.80
TMB6-S	682831	7373037	16	1.31	1.08	1.51
TMB7-S	681358	7373521	16	4.09	4.09	4.09
TMB8-S	682254	7374255	16	-5.18	-5.27	-5.06
VWP19BWM01-2	689179	7376894	6	-3.66	-5.83	2.95
VWP19BWM01-4	689179	7376894	7	4.08	-0.20	5.27
VWP19BWM01-5	689179	7376894	9	2.18	1.51	3.09
VWP19BWM02-1	691840	7365921	7	-27.96	-34.15	-19.66
VWP19BWM02-2	691840	7365921	9	-13.04	-15.10	-9.05
VWP19BWM02-3	691840	7365921	11	-10.18	-12.01	-6.05
VWP19BWM02-4	691840	7365921	12	-11.87	-14.27	-8.33
VWP19BWM02-5	691840	7365921	14	-7.06	-12.05	-0.77
VWP19BWM03-2	672843	7334855	7	-23.30	-23.97	-21.56
VWP19BWM03-4	672843	7334855	9	-20.39	-22.05	-18.40
VWP19BWM03-5	672843	7334855	12	-18.64	-20.24	-16.54
VWP19BWM04-1	682417	7330805	6	-22.83	-24.10	-20.93
VWP19BWM04-2	682417	7330805	7	-12.17	-13.11	-11.01



ID	Easting	Northing	Layer	Average Residual	Min	Max
VWP19BWM04-3	682417	7330805	8	9.38	8.91	9.94
VWP19BWM04-4	682417	7330805	11	8.25	7.18	9.59
VWP19BWM04-5	682417	7330805	12	9.52	9.11	10.32

Appendix B Calibration Hydrographs

Blackwater North Extension Project

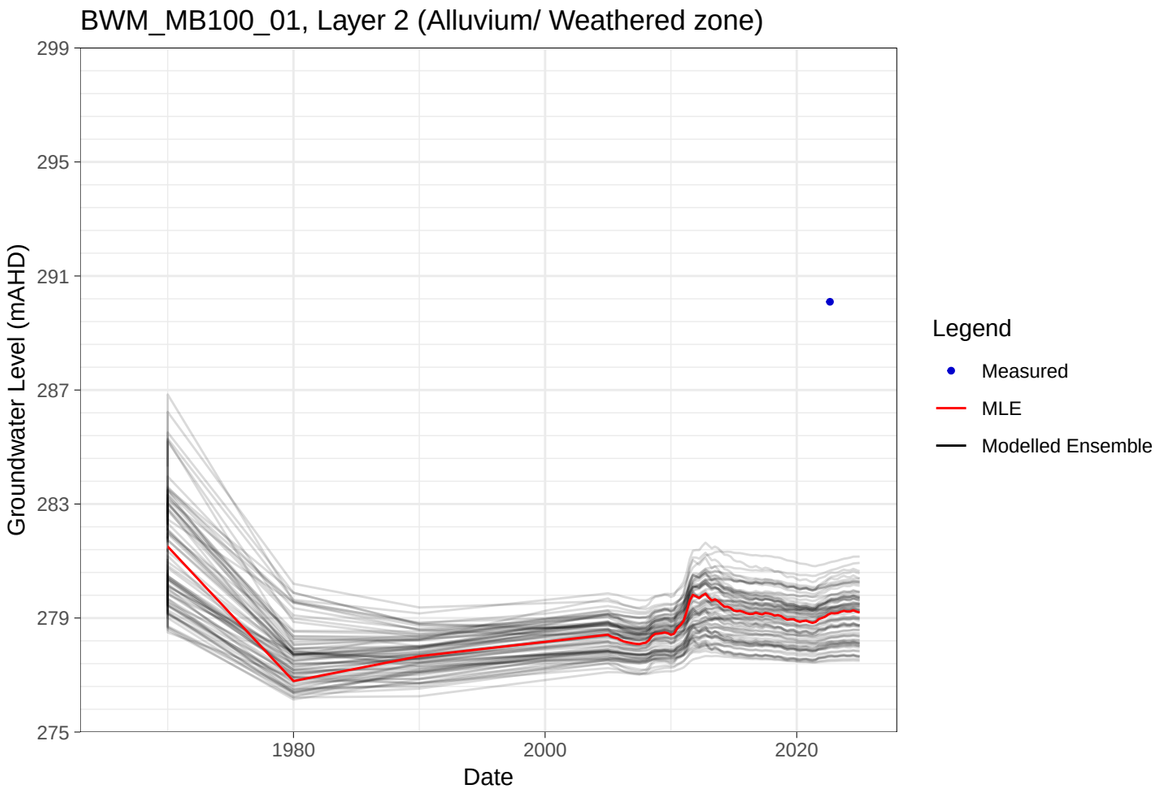
Groundwater Modelling Technical Report

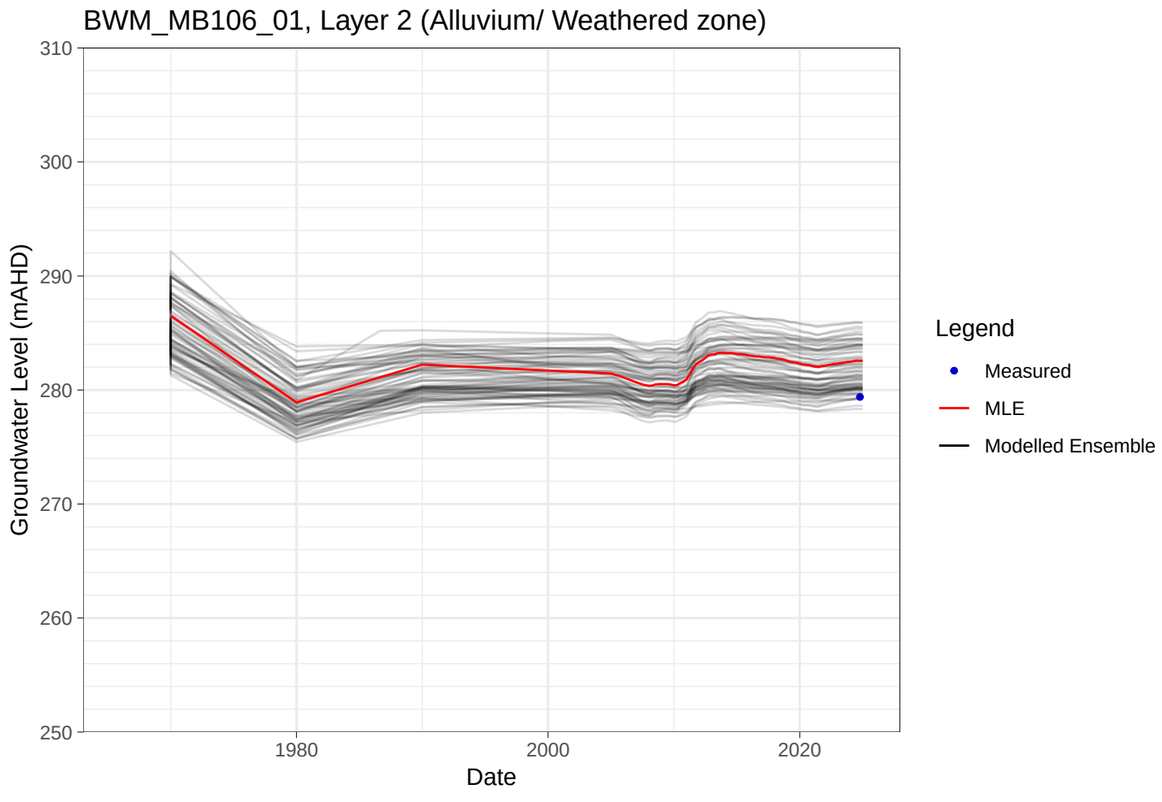
Whitehaven Blackwater Pty Ltd

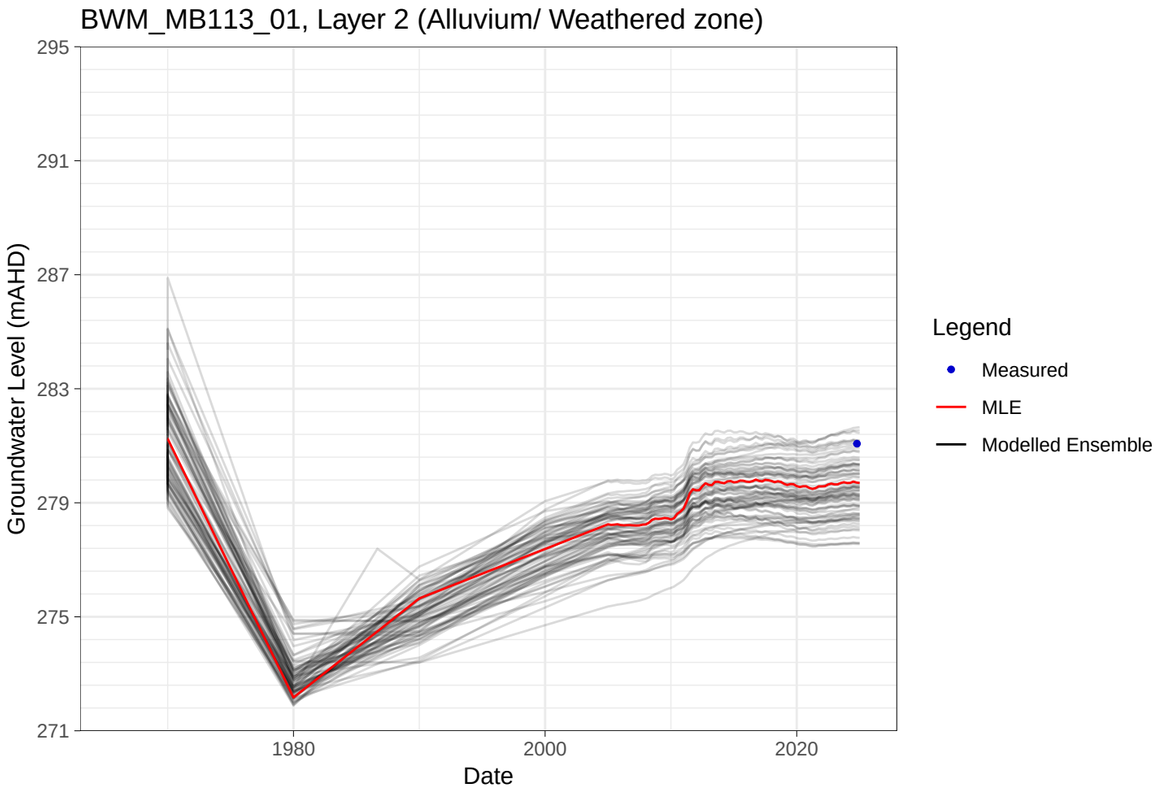
SLR Project No.: 640.031809.00001

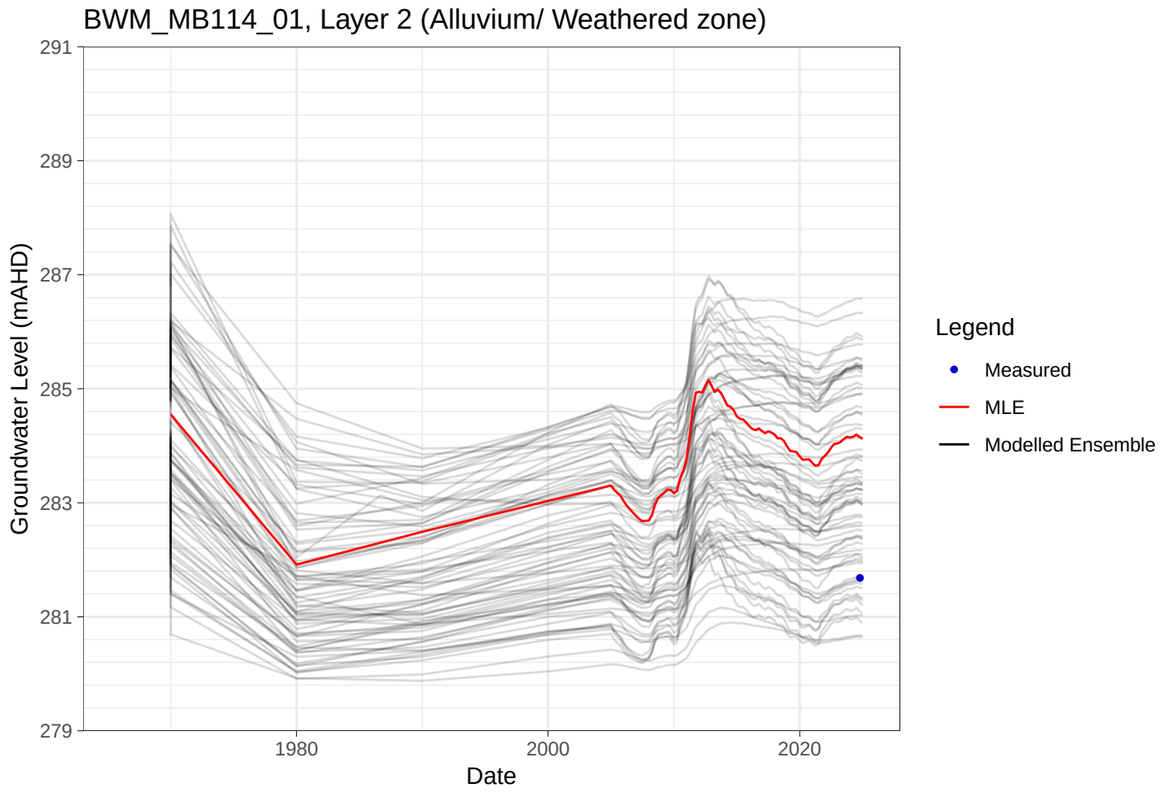
7 October 2026

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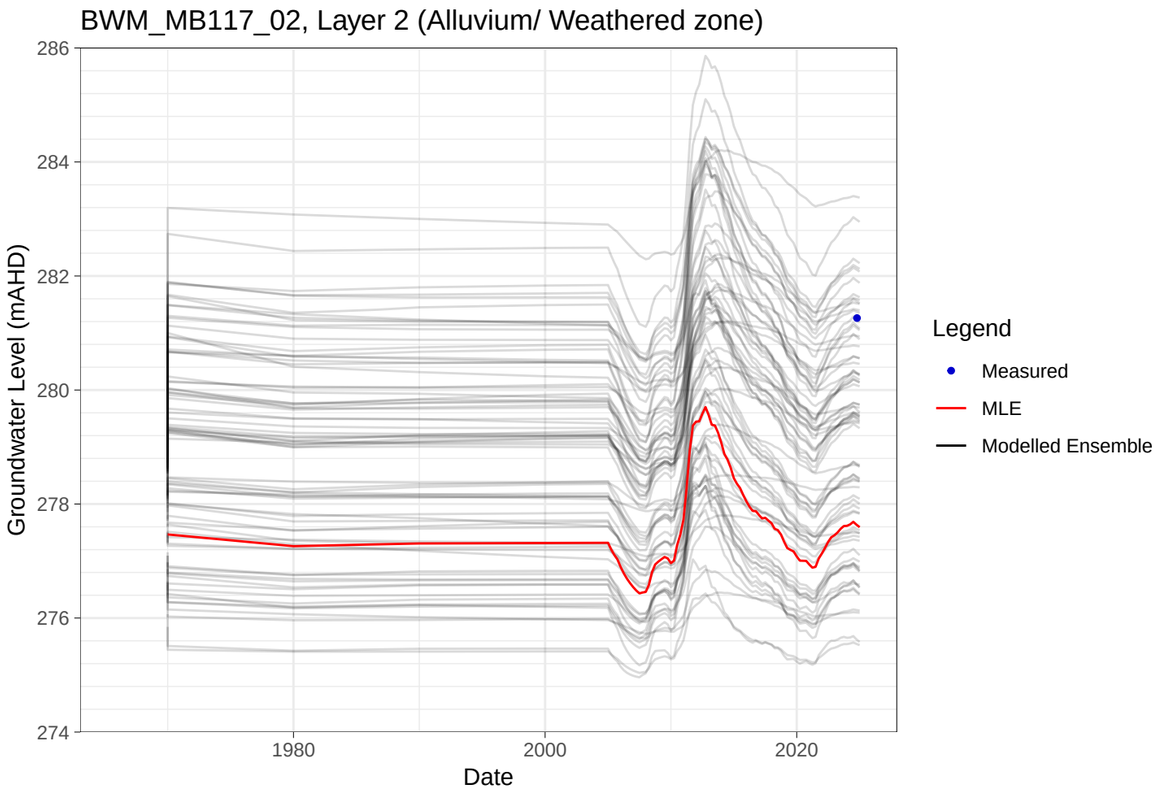

BWM_MB100_01, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
299
295
291
287
283
279
275
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

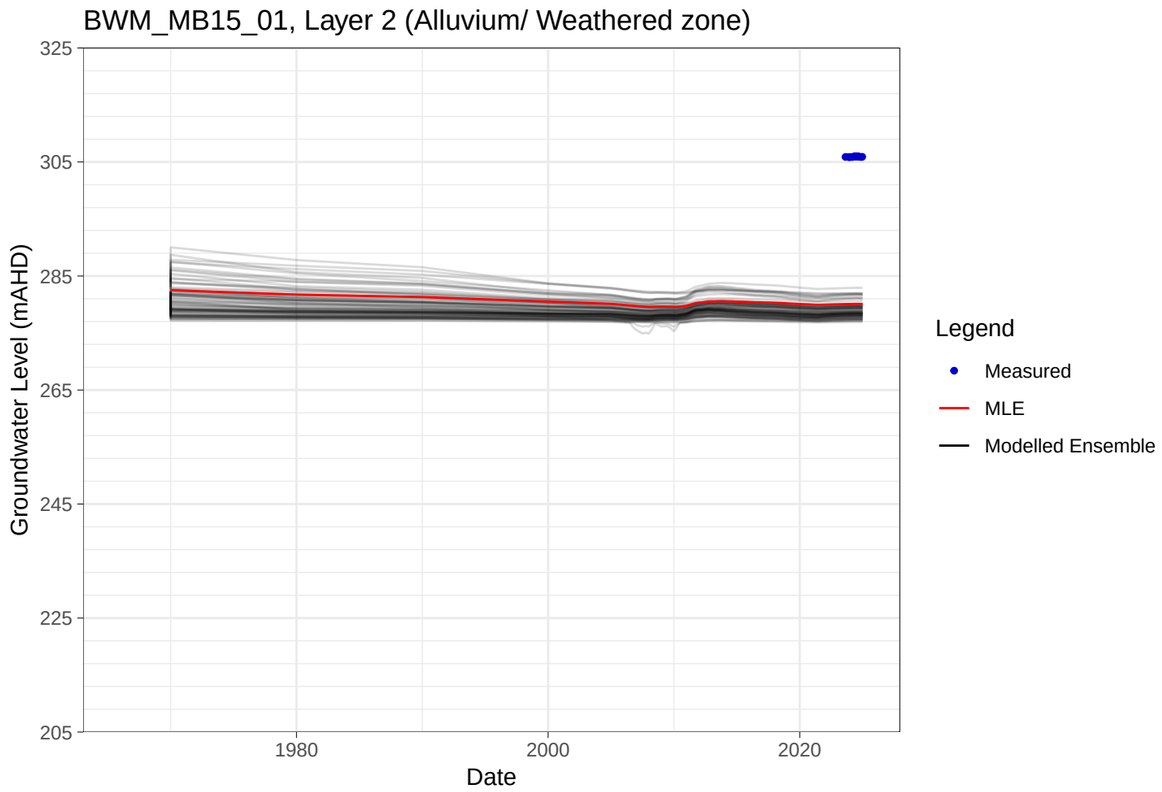

BWM_MB106_01, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
310
300
290
280
270
260
250
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

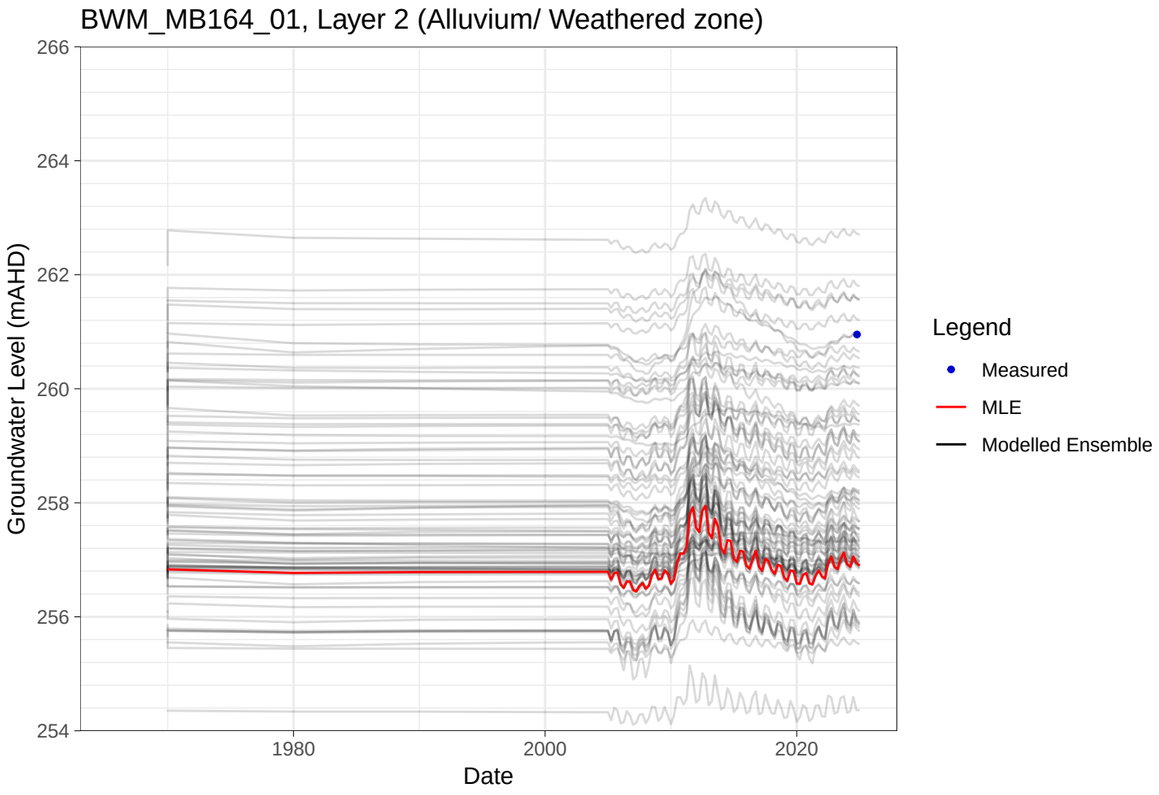

BWM_MB113_01, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
295
291
287
283
279
275
271
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

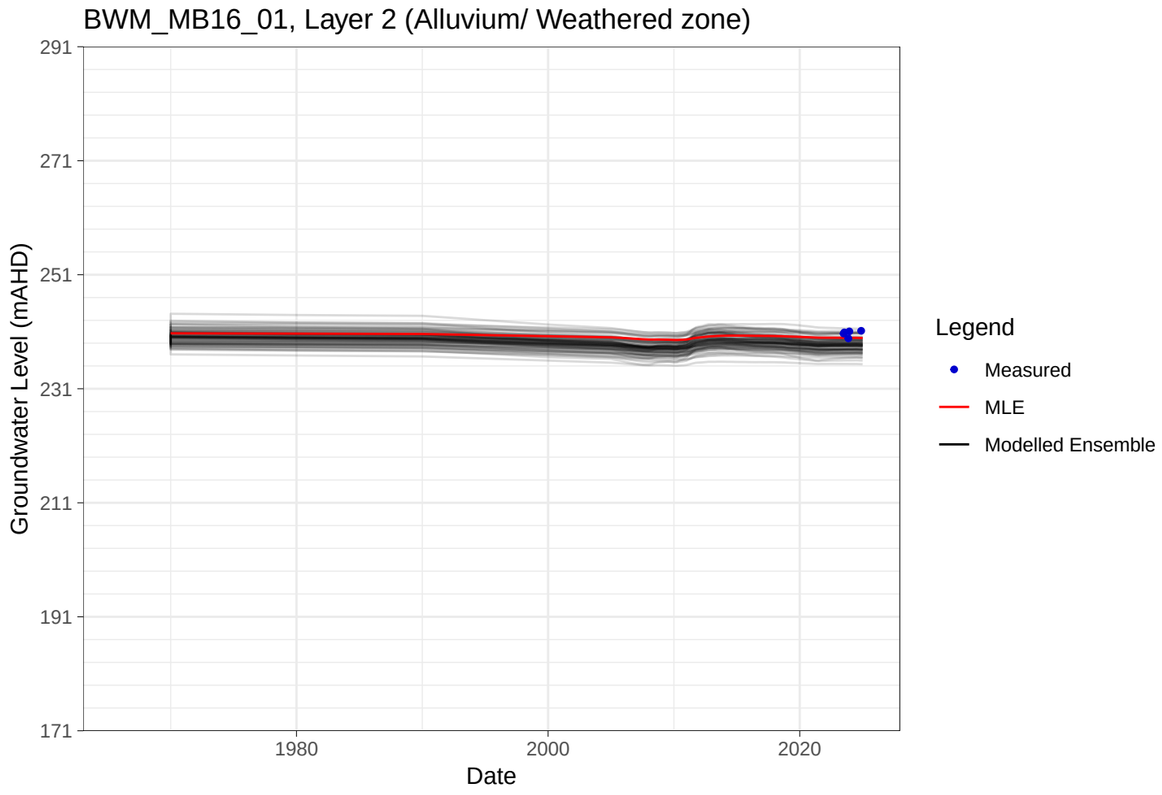

BWM_MB114_01, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
291
289
287
285
283
281
279
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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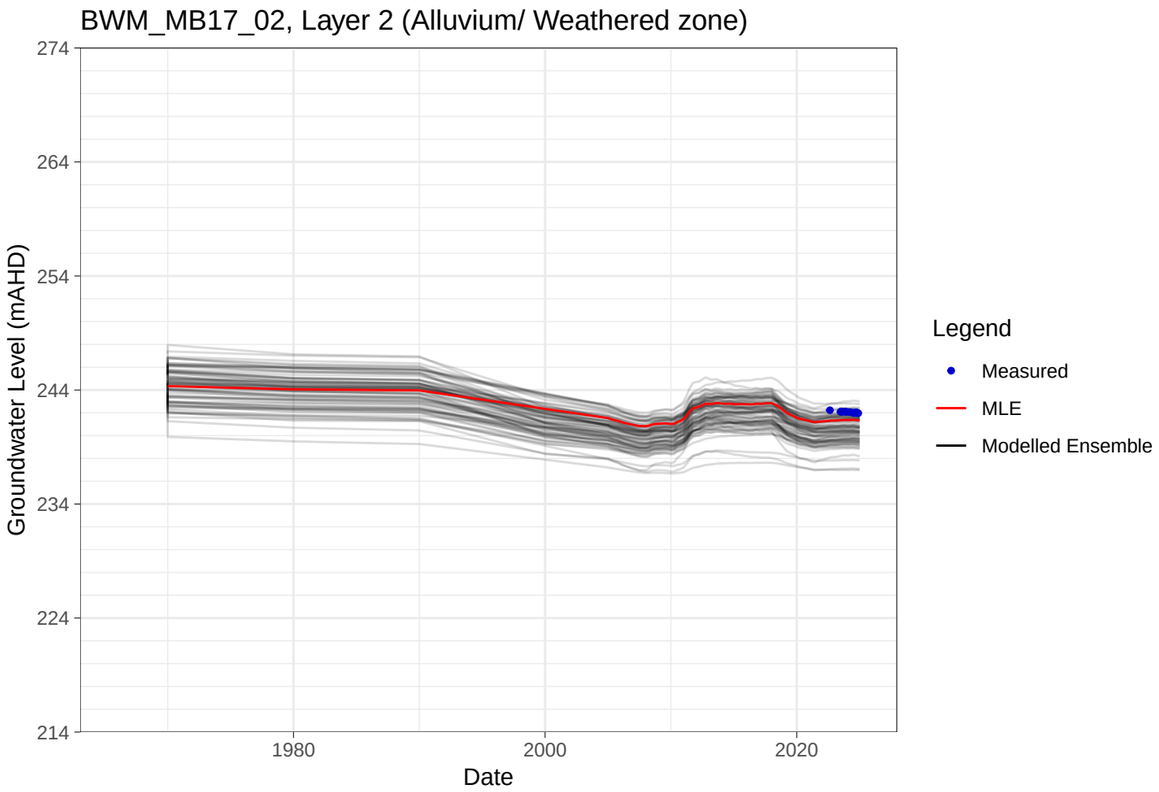

BWM_MB117_02, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
286
284
282
280
278
276
274
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

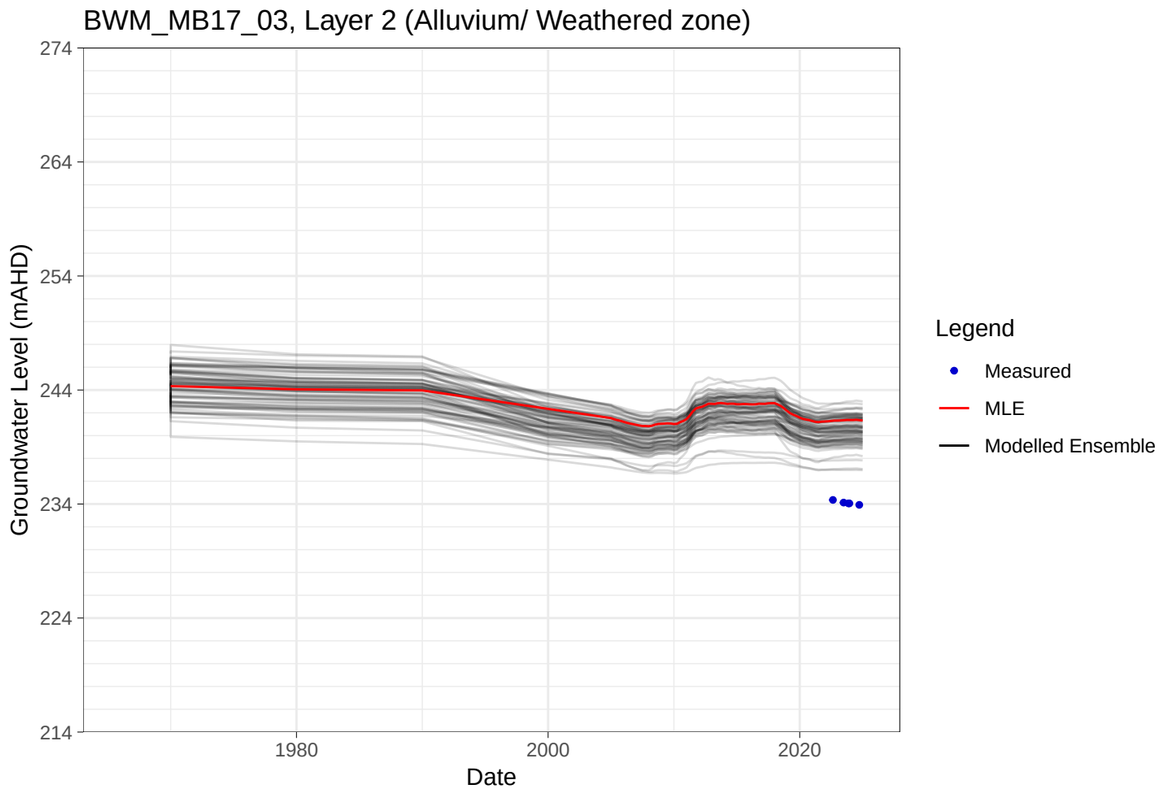

BWM_MB15_01, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
325
305
285
265
245
225
205
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

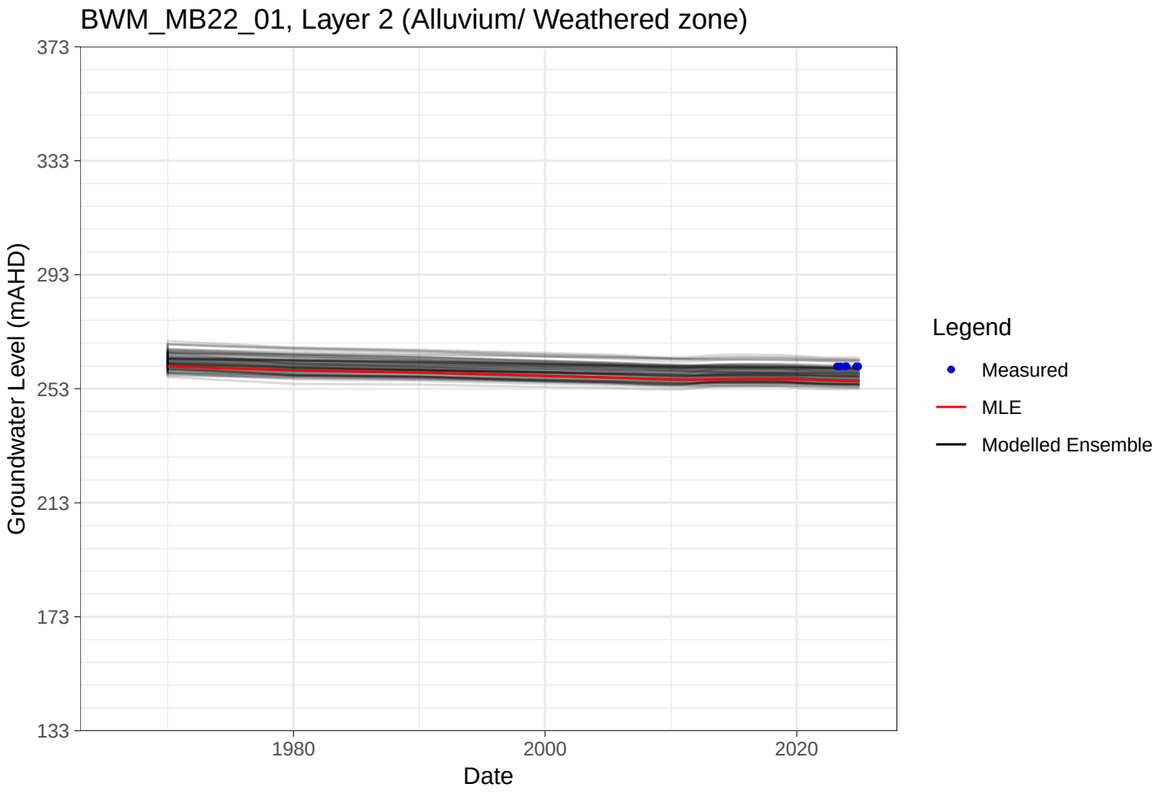

BWM_MB164_01, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
266
264
262
260
258
256
254
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

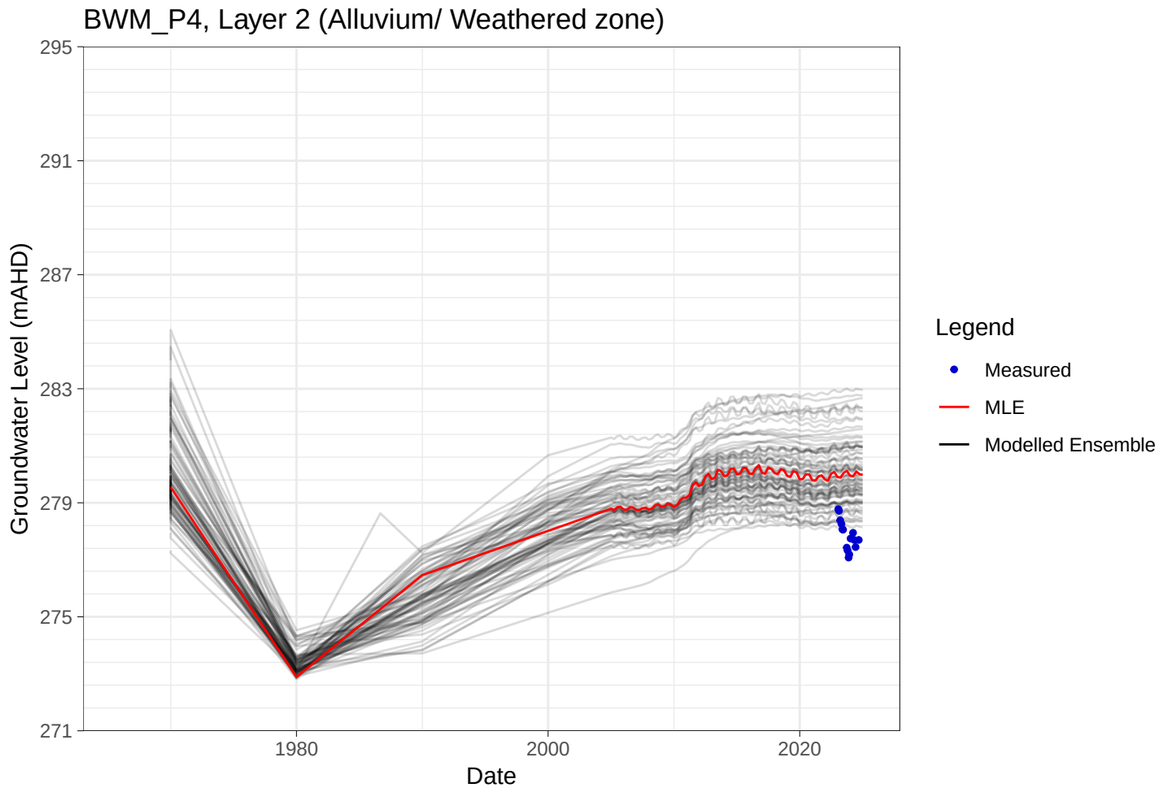

BWM_MB16_01, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
291
271
251
231
211
191
171
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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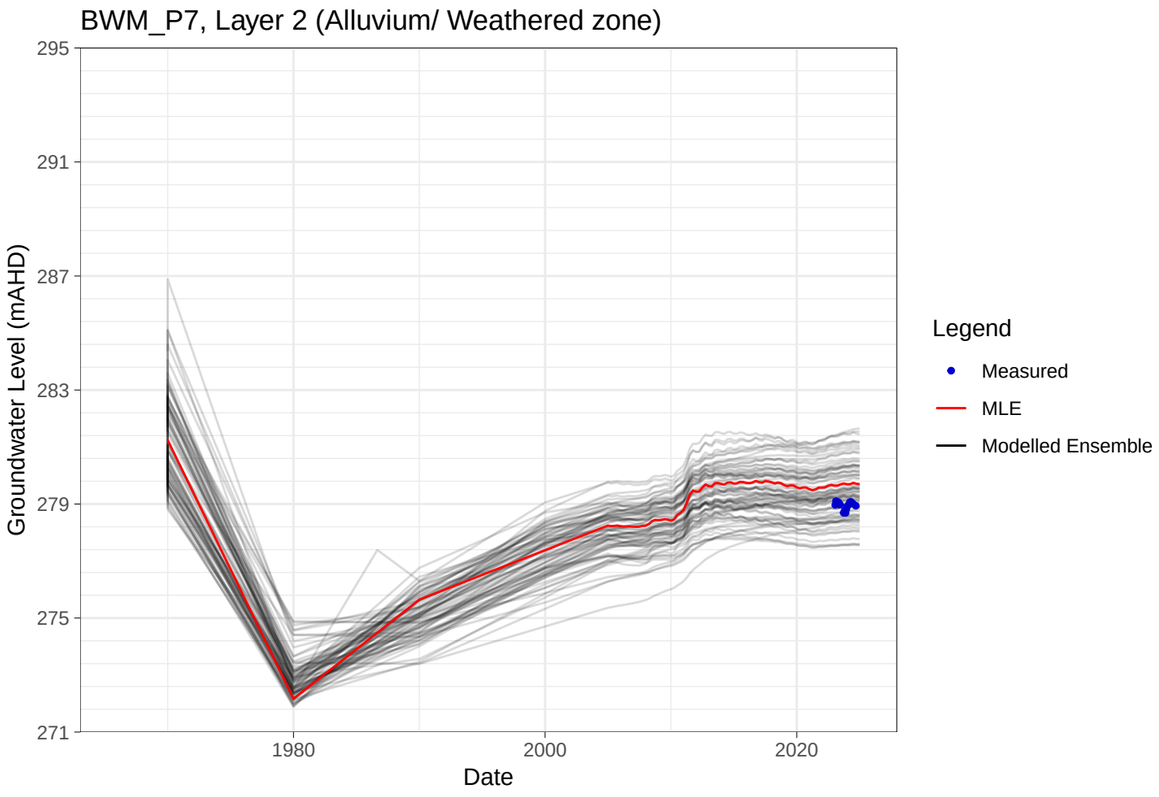

BWM_MB17_02, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
274
264
254
244
234
224
214
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

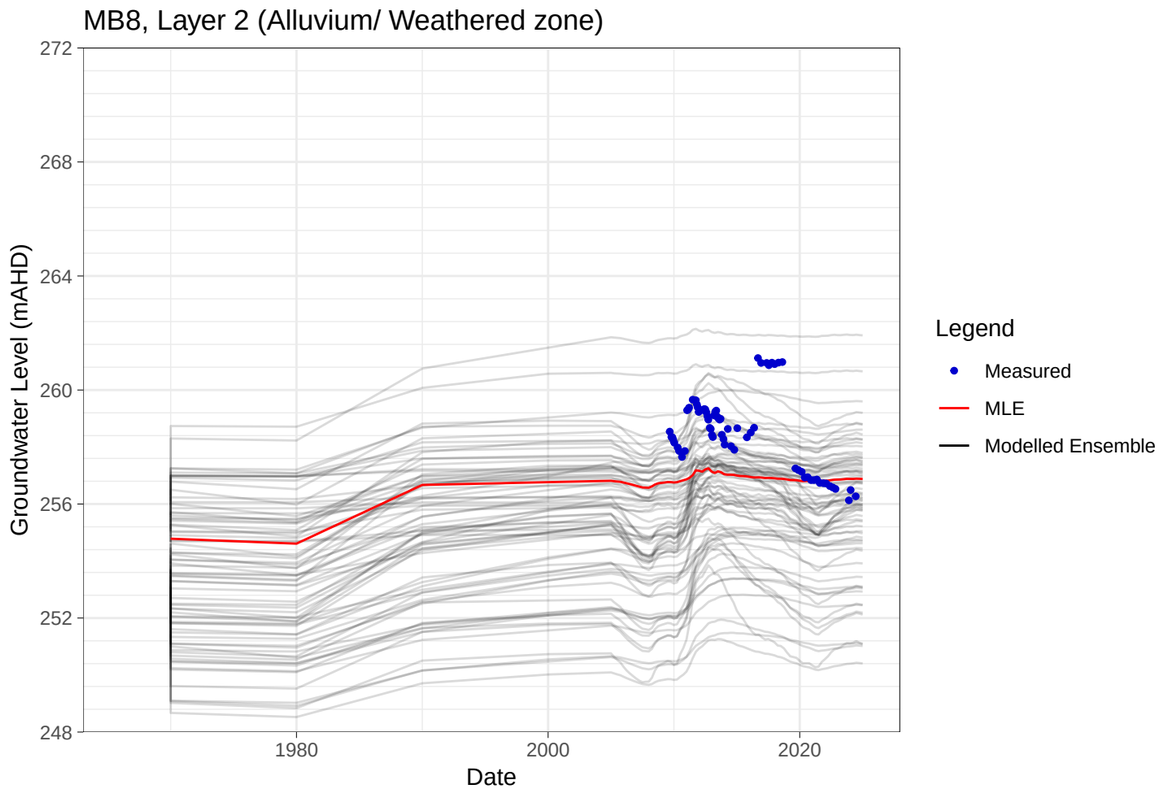

BWM_MB17_03, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
274
264
254
244
234
224
214
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

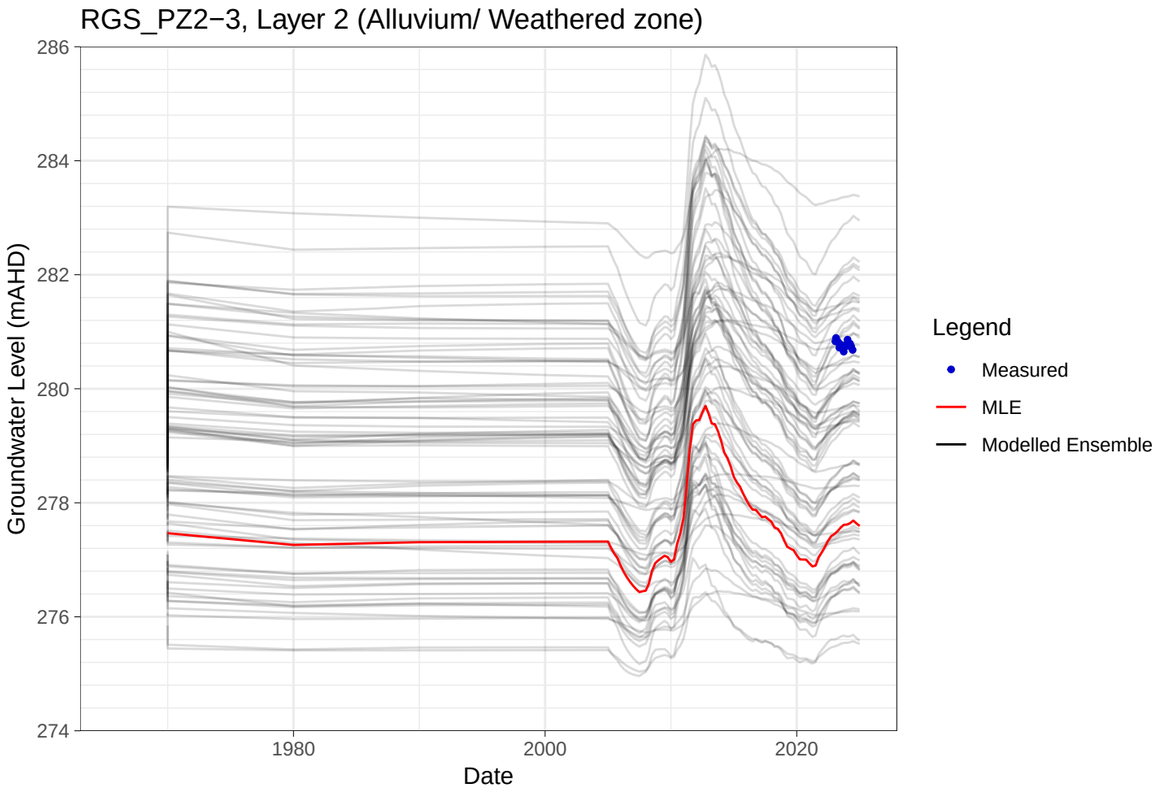

BWM_MB22_01, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
373
333
293
253
213
173
133
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

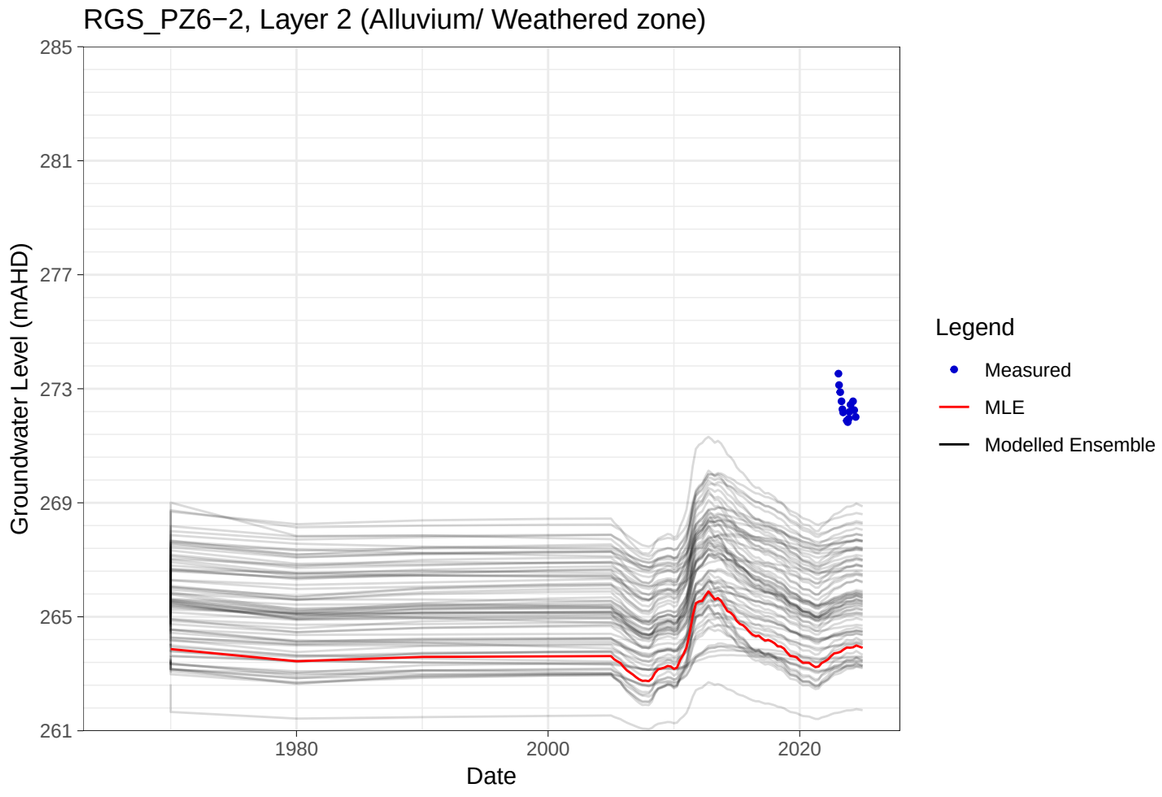

BWM_P4, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
295
291
287
283
279
275
271
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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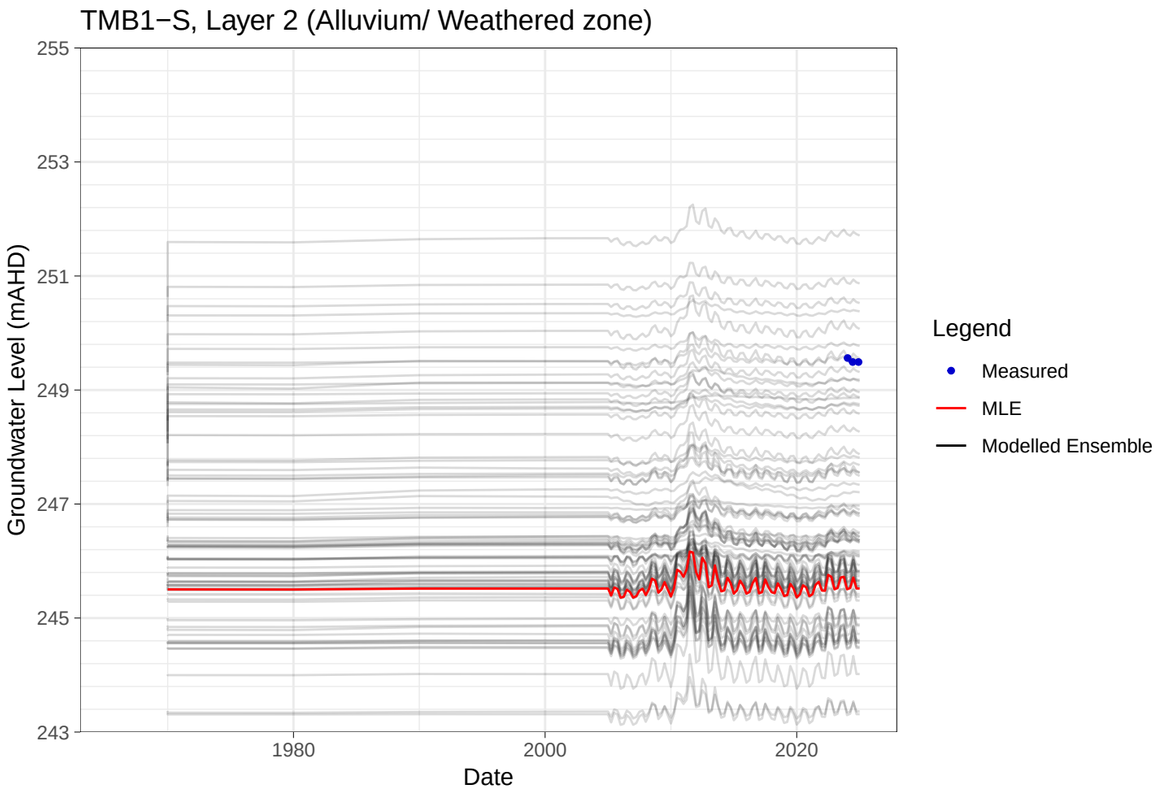

BWM_P7, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
295
291
287
283
279
275
271
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

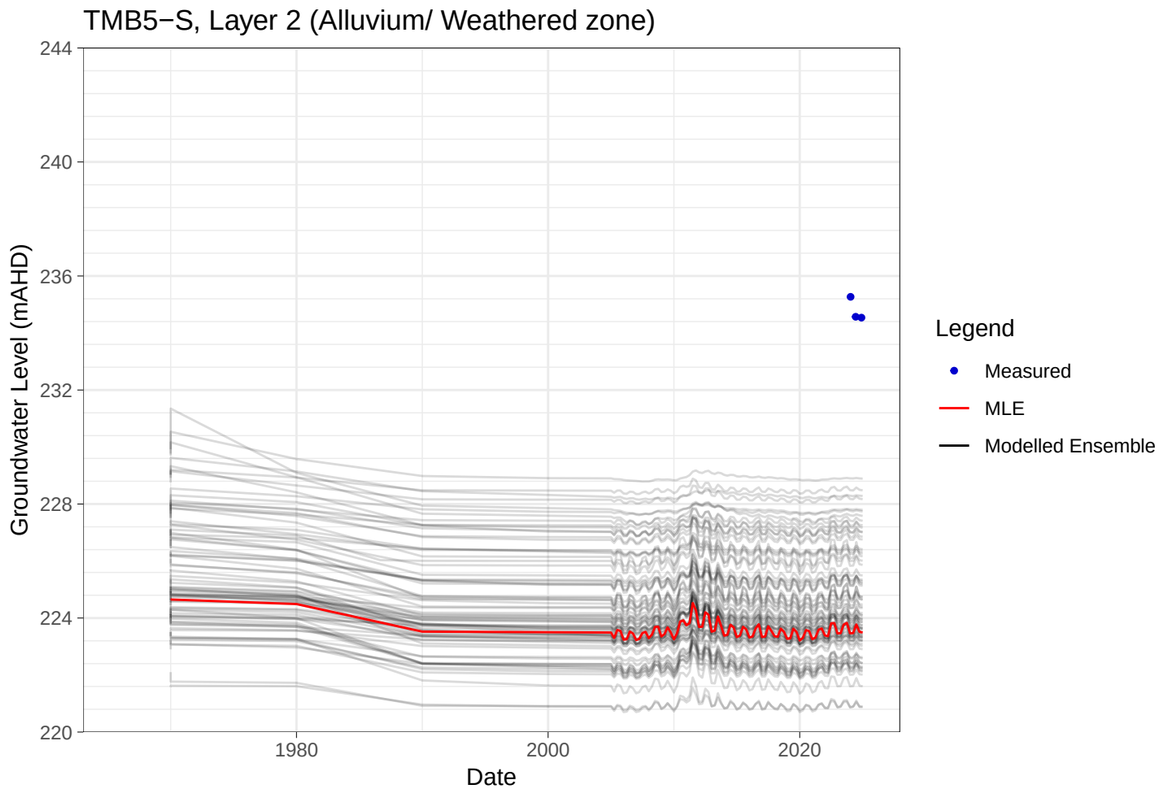

MB8, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
272
268
264
260
256
252
248
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

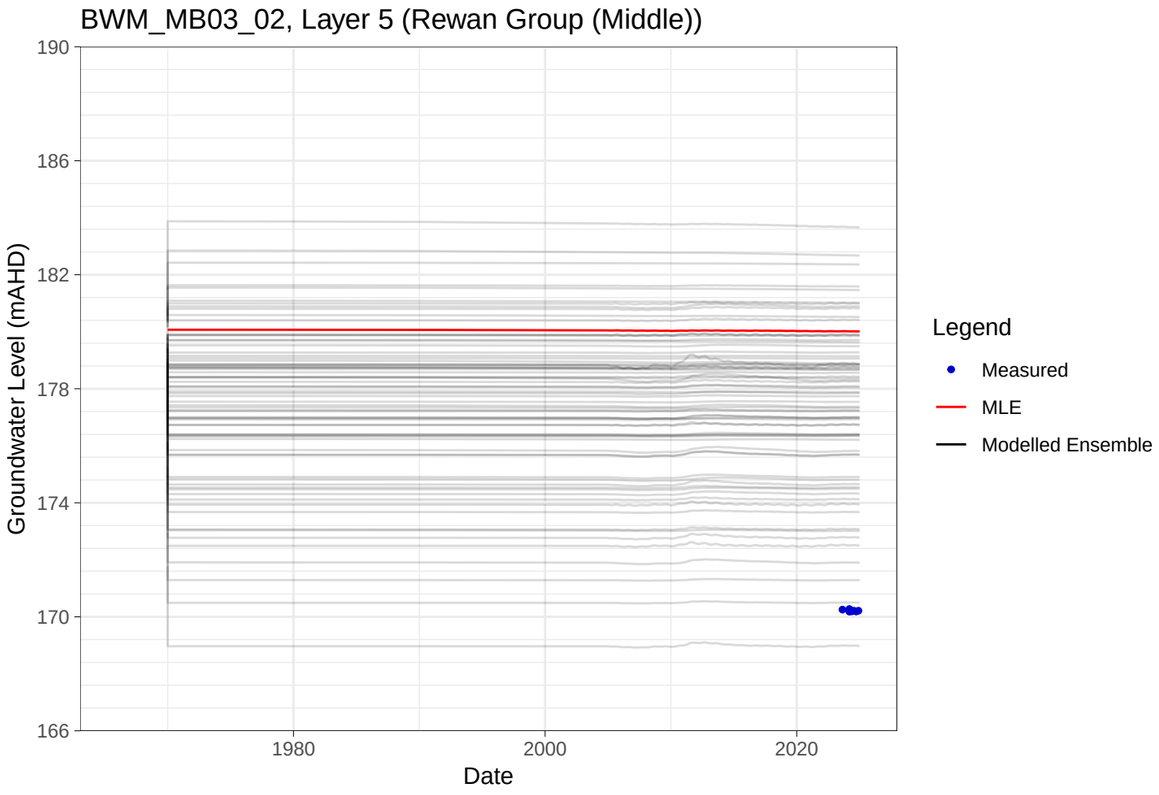

RGS_PZ2−3, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
286
284
282
280
278
276
274
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

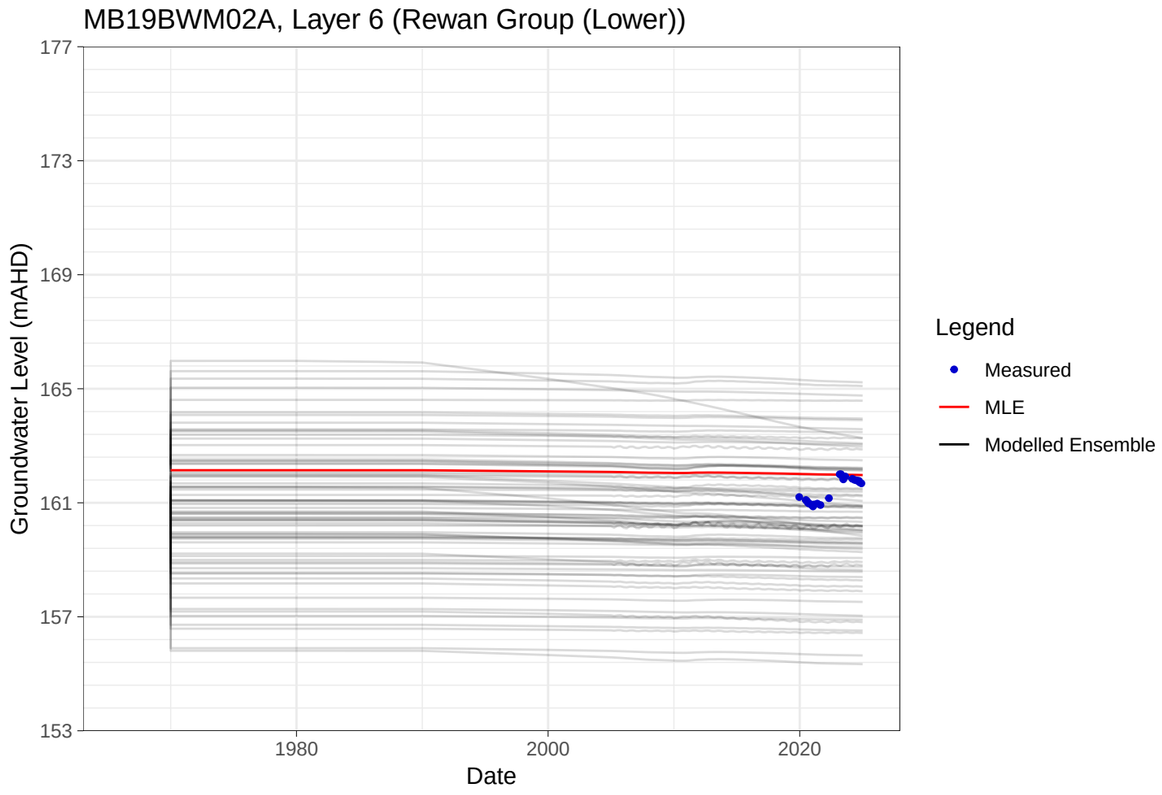

RGS_PZ6−2, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
285
281
277
273
269
265
261
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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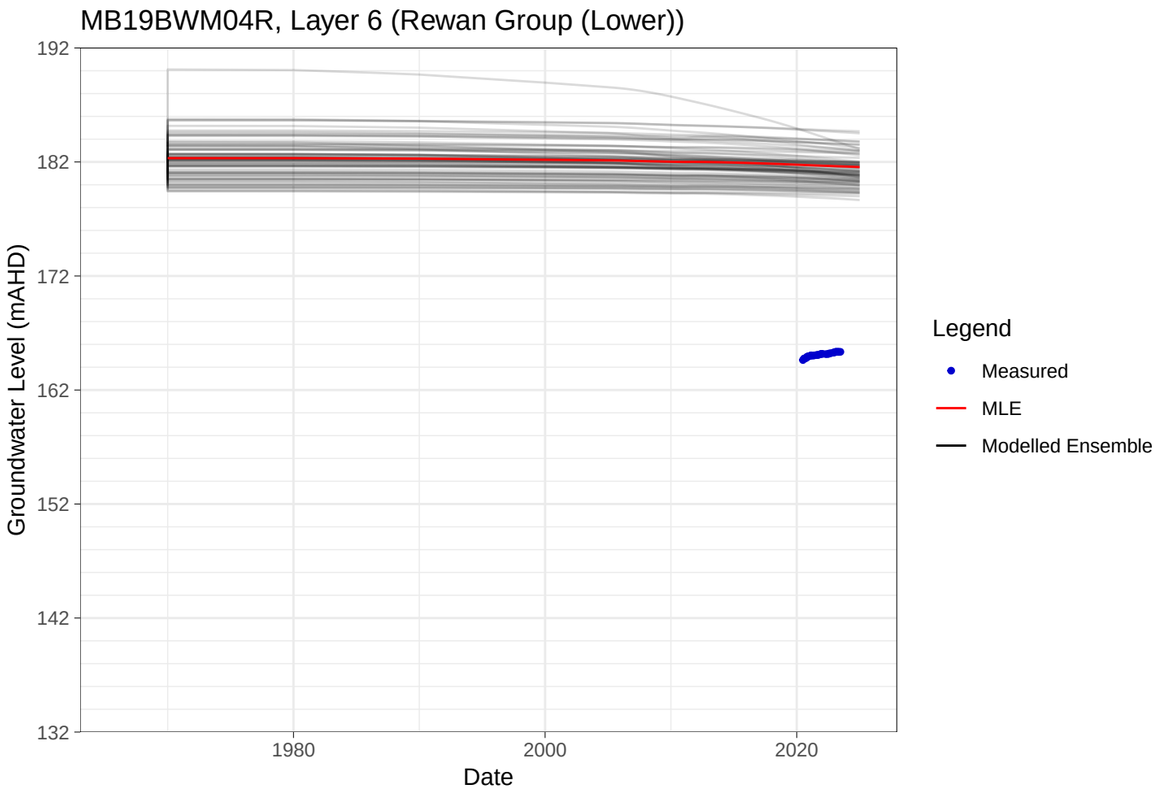

TMB1−S, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
255
253
251
249
247
245
243
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

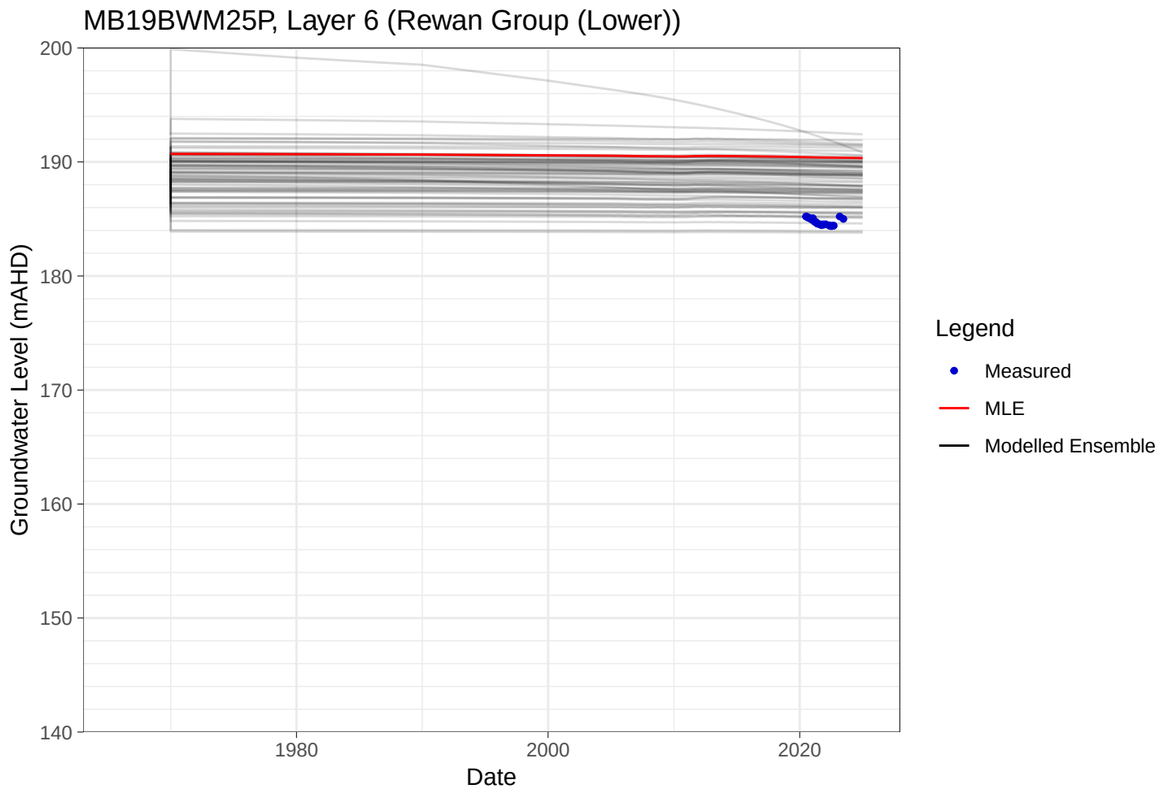

TMB5−S, Layer 2 (Alluvium/ Weathered zone)
Groundwater Level (mAHD)
244
240
236
232
228
224
220
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

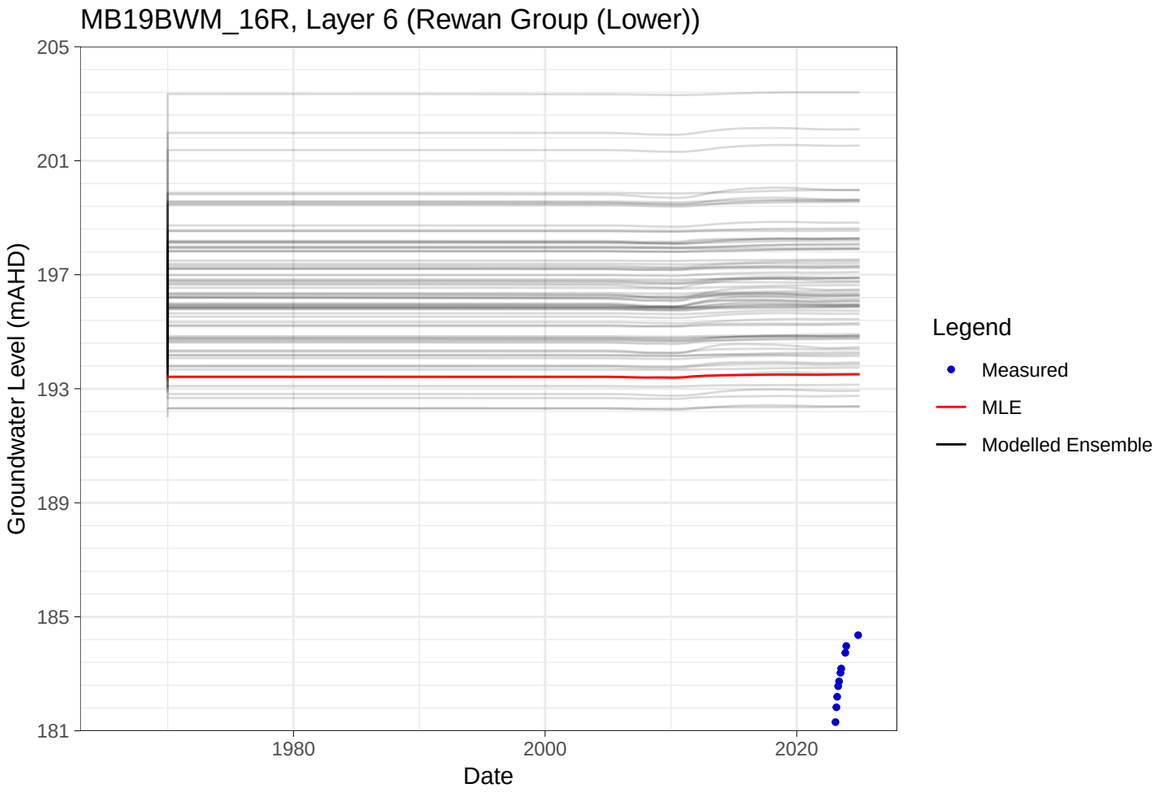

BWM_MB03_02, Layer 5 (Rewan Group (Middle))
Groundwater Level (mAHD)
190
186
182
178
174
170
166
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

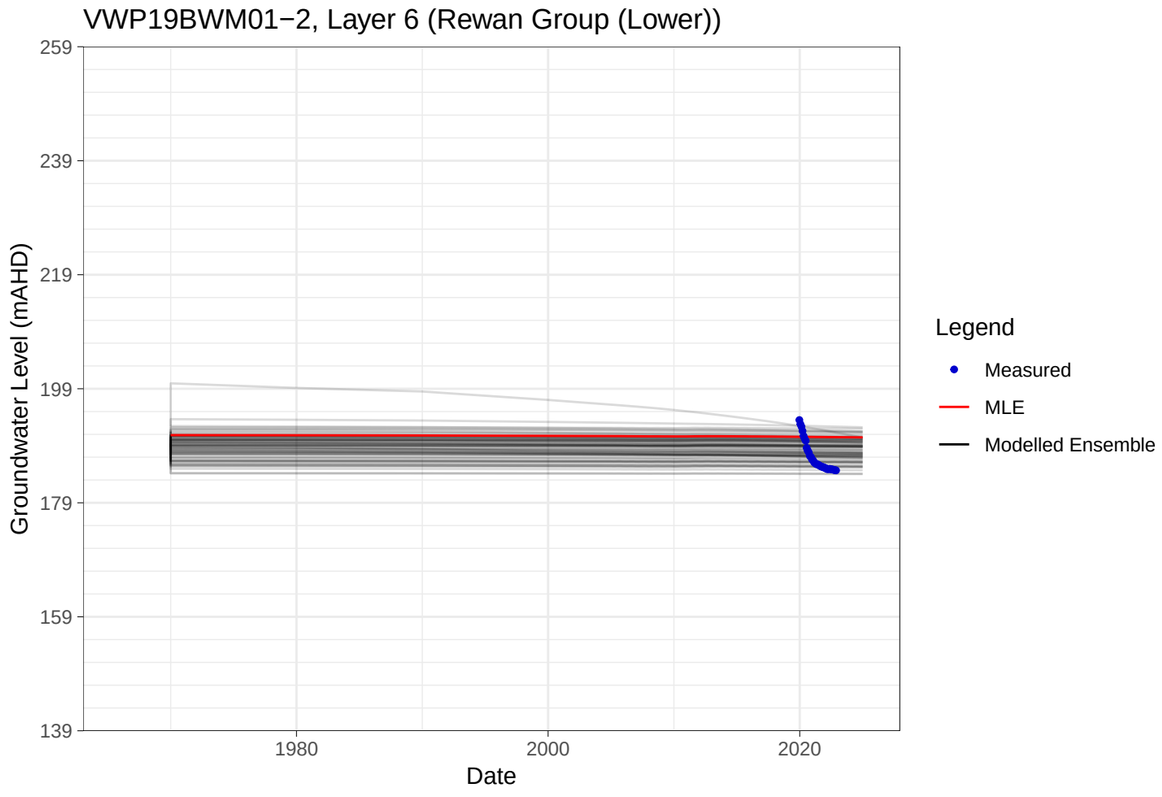

MB19BWM02A, Layer 6 (Rewan Group (Lower))
Groundwater Level (mAHD)
177
173
169
165
161
157
153
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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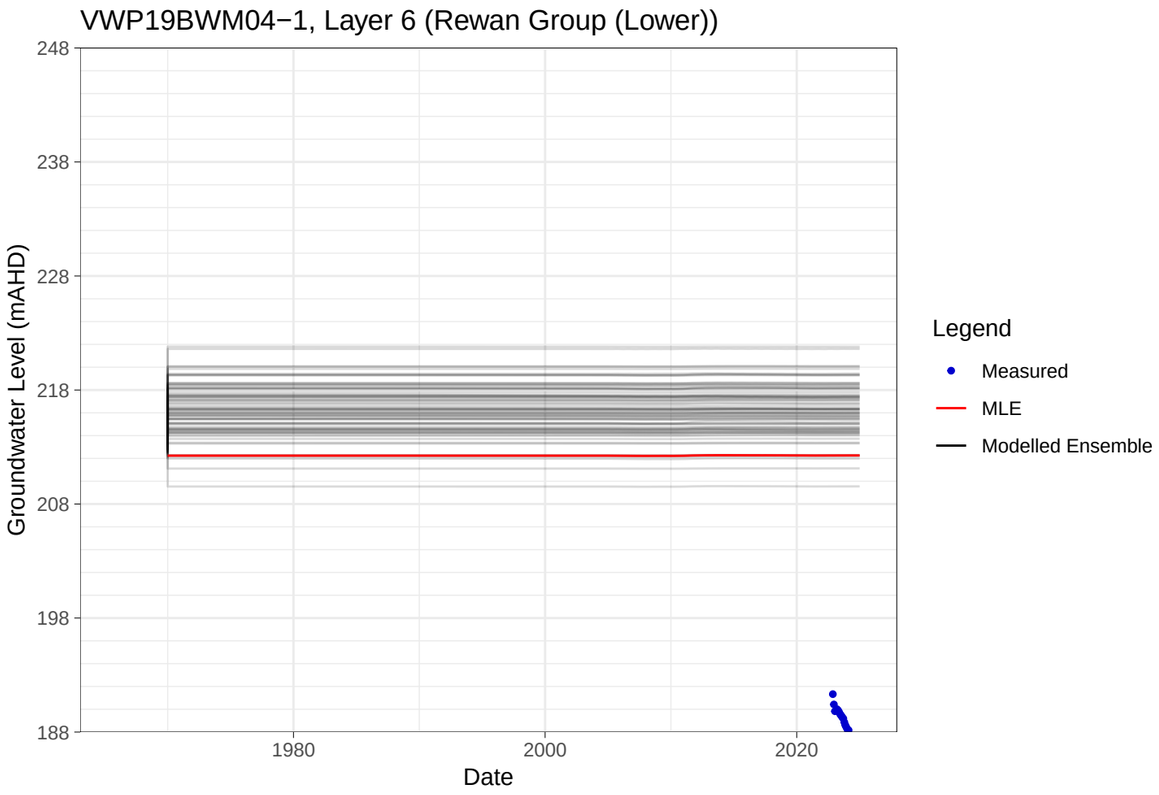

MB19BWM04R, Layer 6 (Rewan Group (Lower))
Groundwater Level (mAHD)
192
182
172
162
152
142
132
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

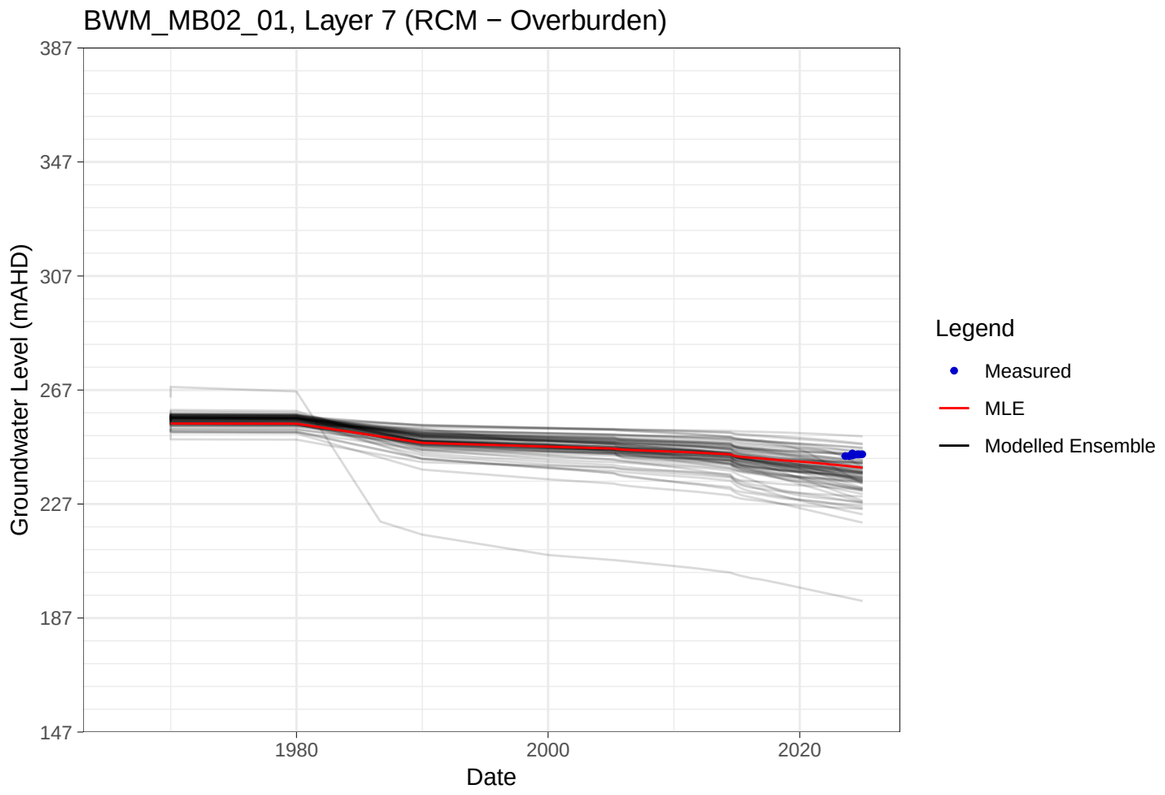

MB19BWM25P, Layer 6 (Rewan Group (Lower))
Groundwater Level (mAHD)
200
190
180
170
160
150
140
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

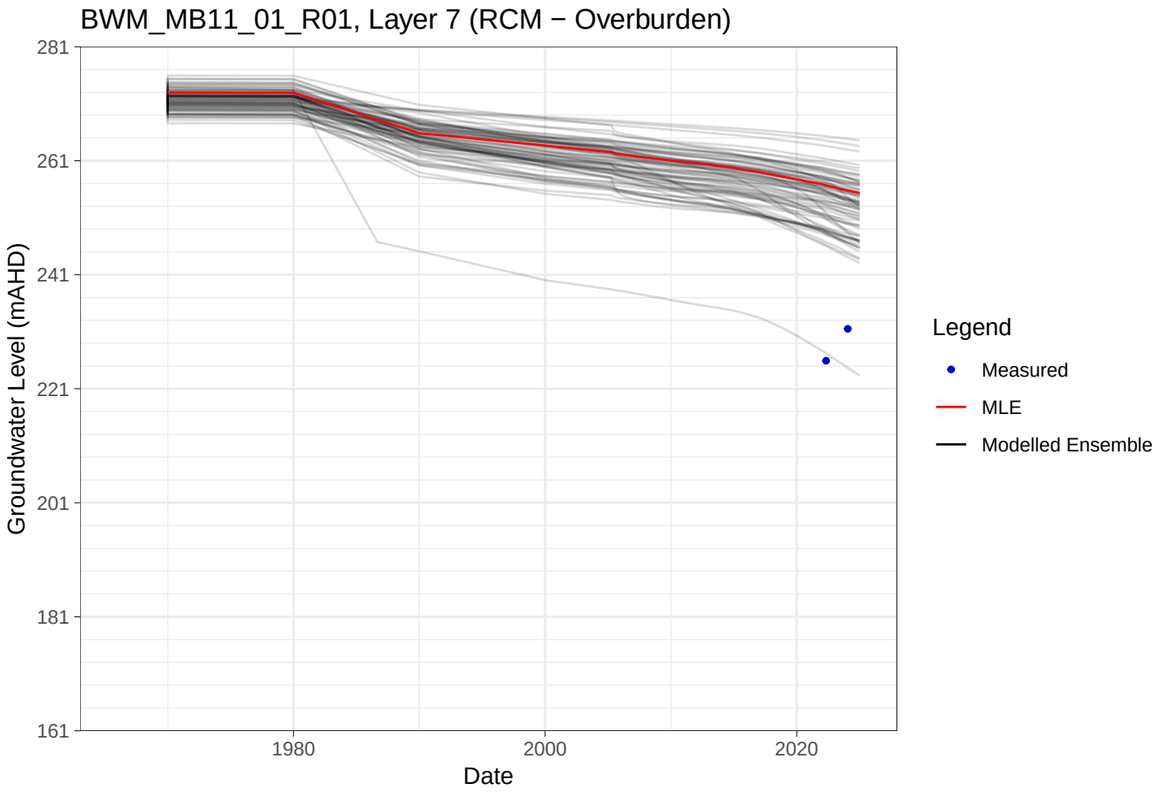

MB19BWM_16R, Layer 6 (Rewan Group (Lower))
Groundwater Level (mAHD)
205
201
197
193
189
185
181
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

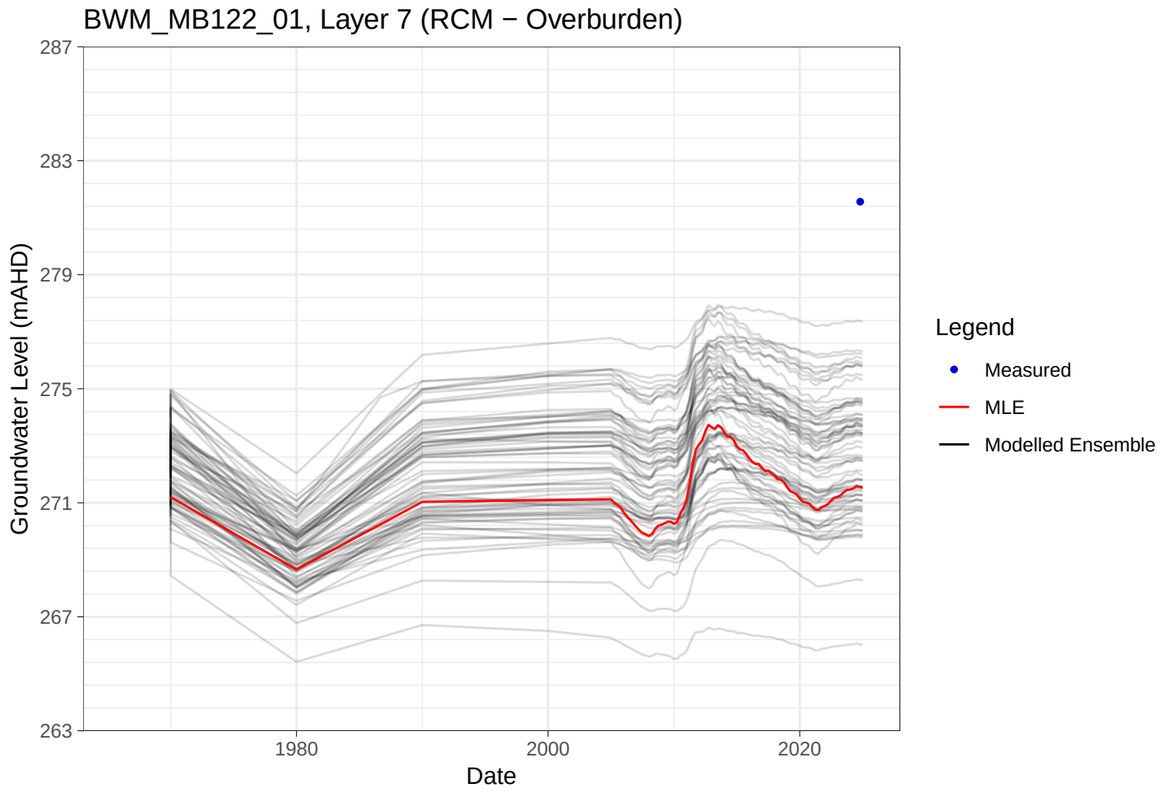

VWP19BWM01−2, Layer 6 (Rewan Group (Lower))
Groundwater Level (mAHD)
259
239
219
199
179
159
139
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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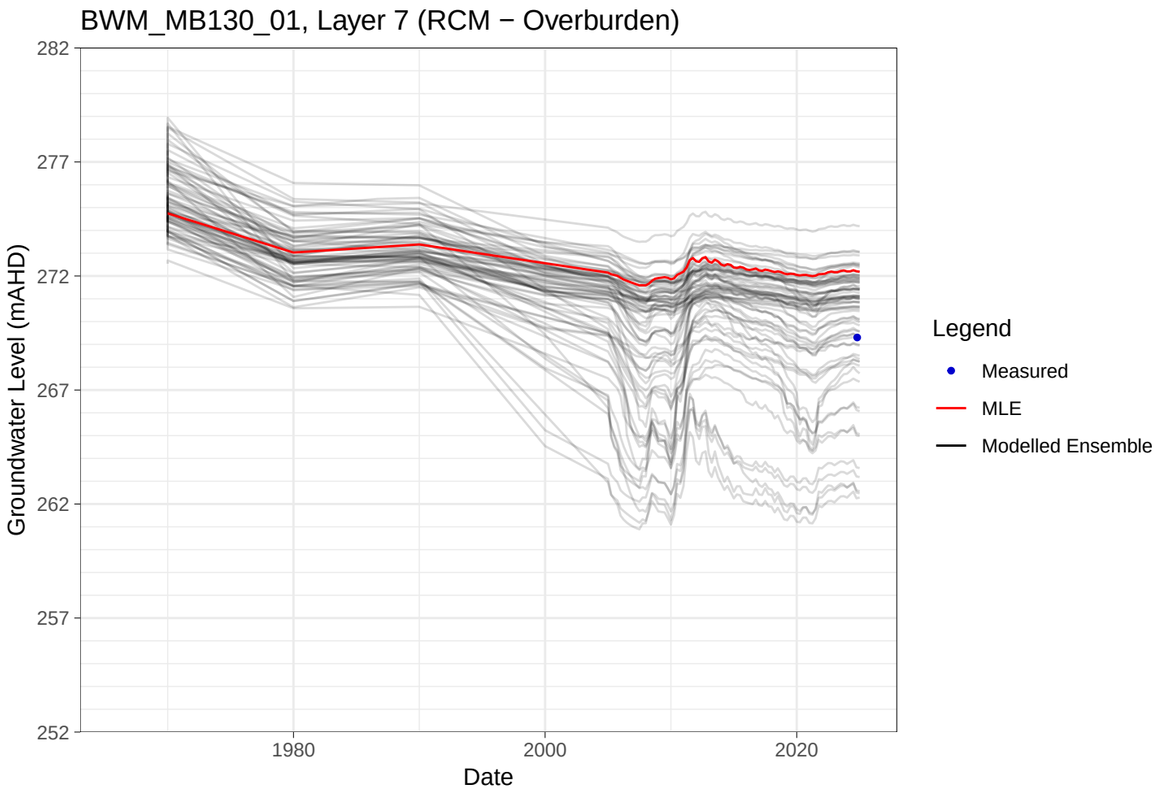

VWP19BWM04−1, Layer 6 (Rewan Group (Lower))
Groundwater Level (mAHD)
248
238
228
218
208
198
188
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

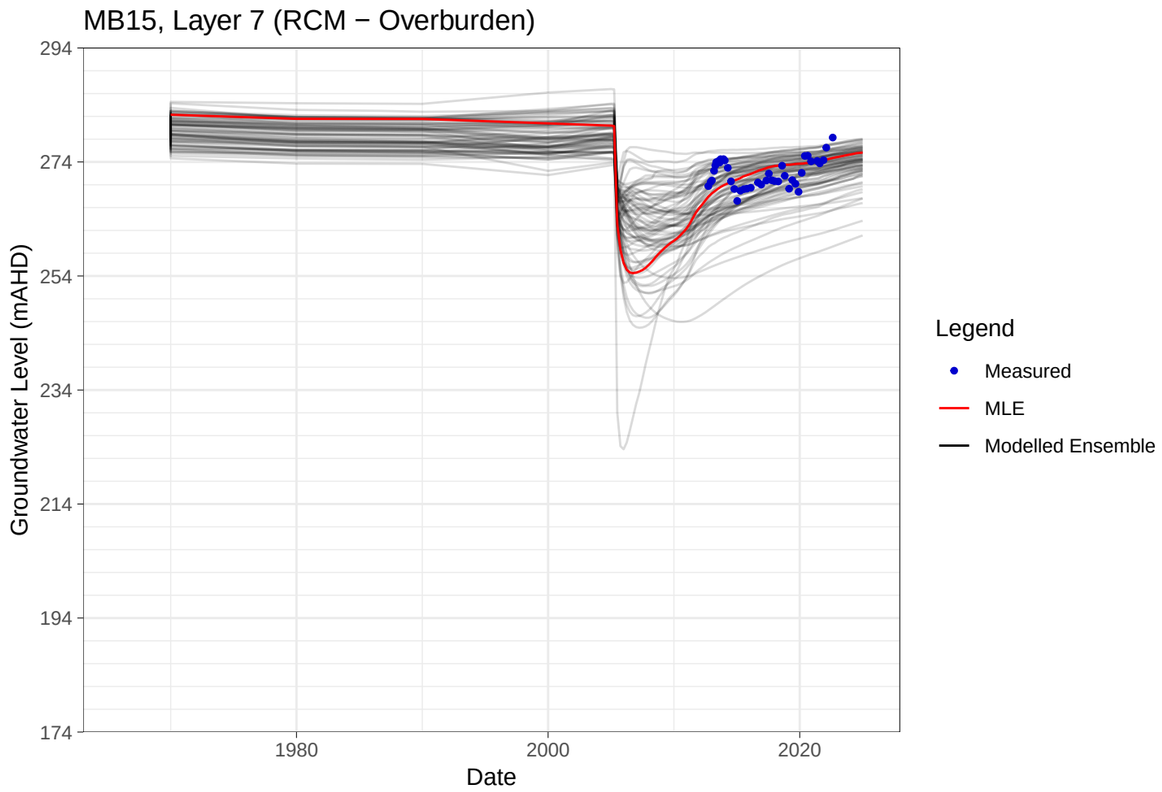

BWM_MB02_01, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
387
347
307
267
227
187
147
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

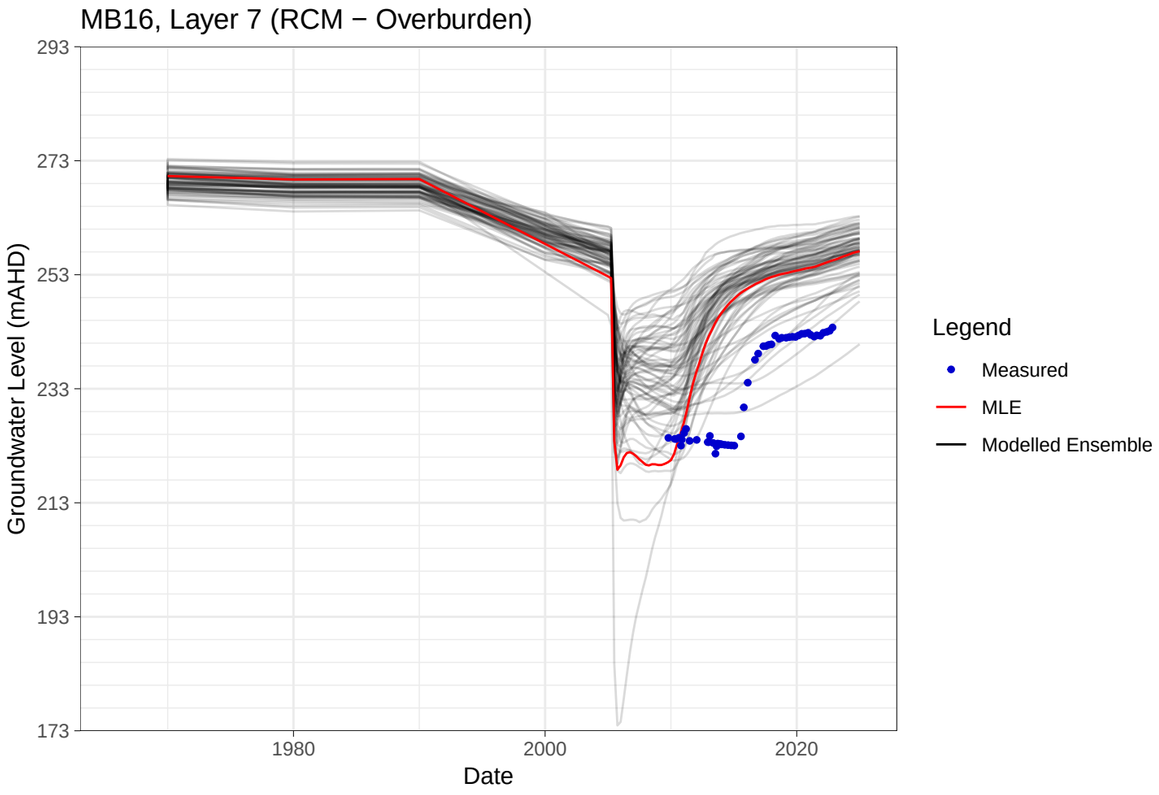

BWM_MB11_01_R01, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
281
261
241
221
201
181
161
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

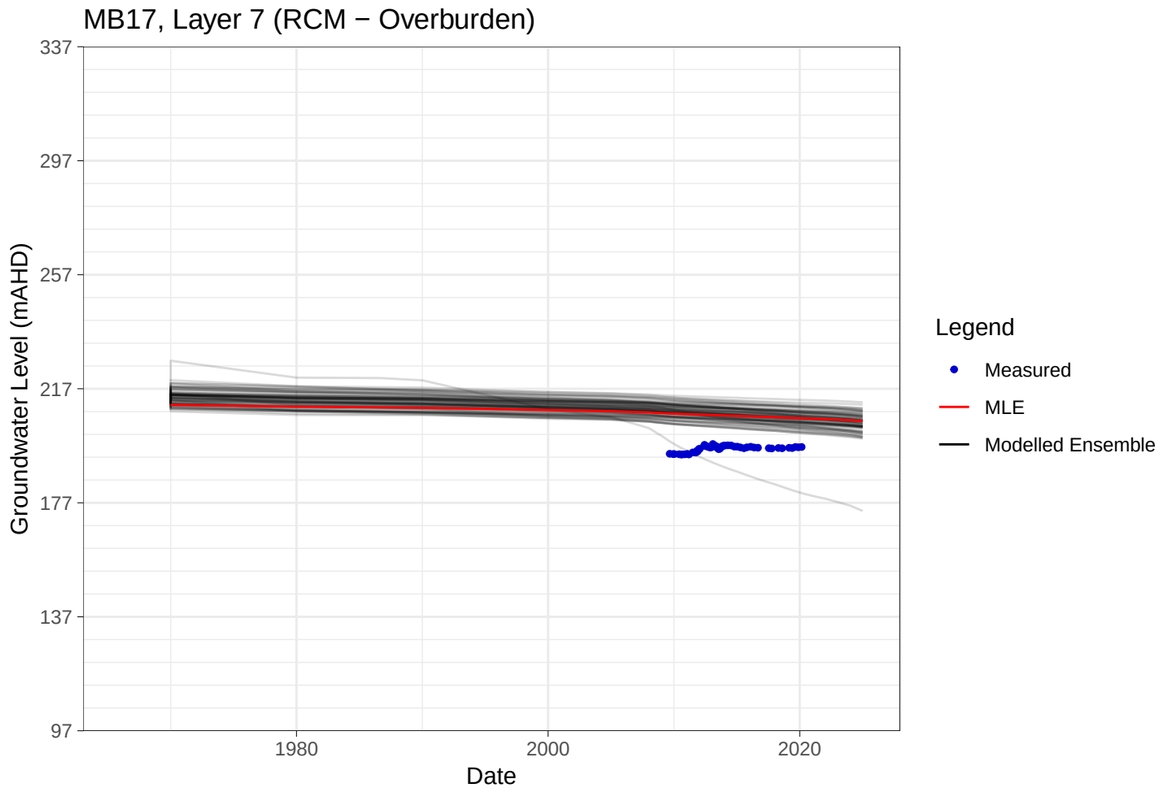

BWM_MB122_01, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
287
283
279
275
271
267
263
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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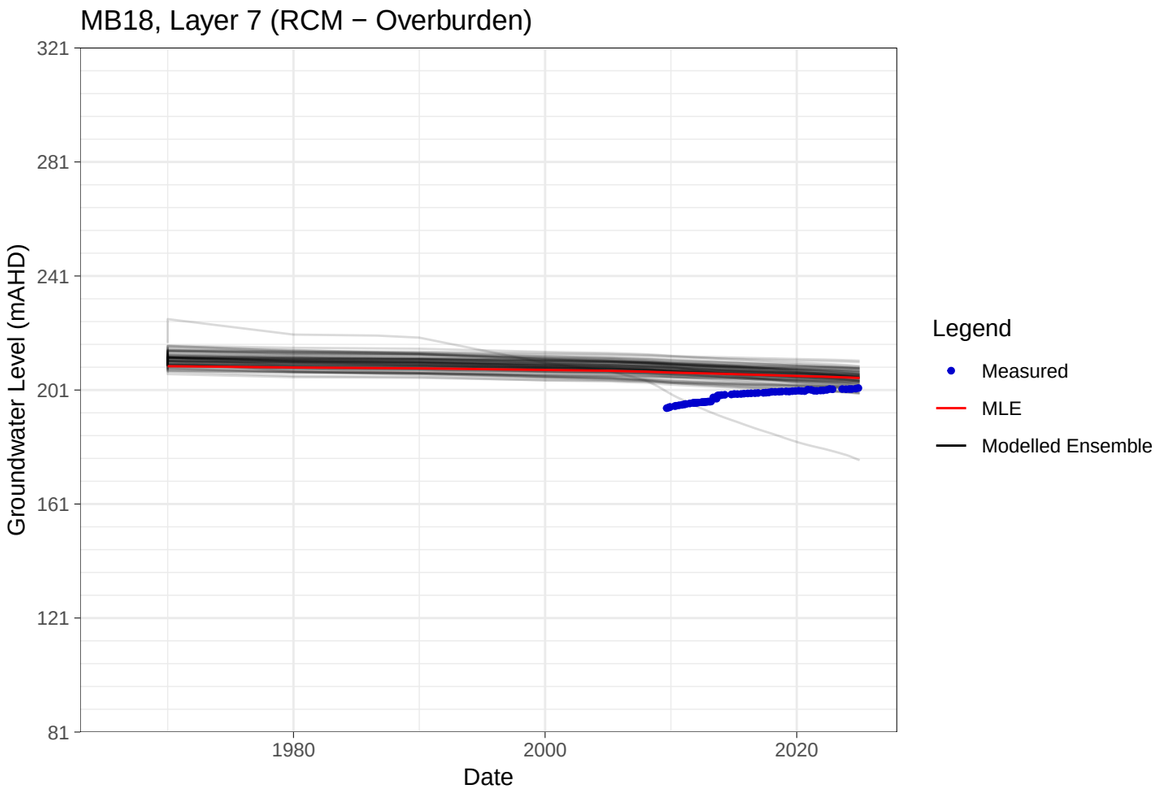

BWM_MB130_01, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
282
277
272
267
262
257
252
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

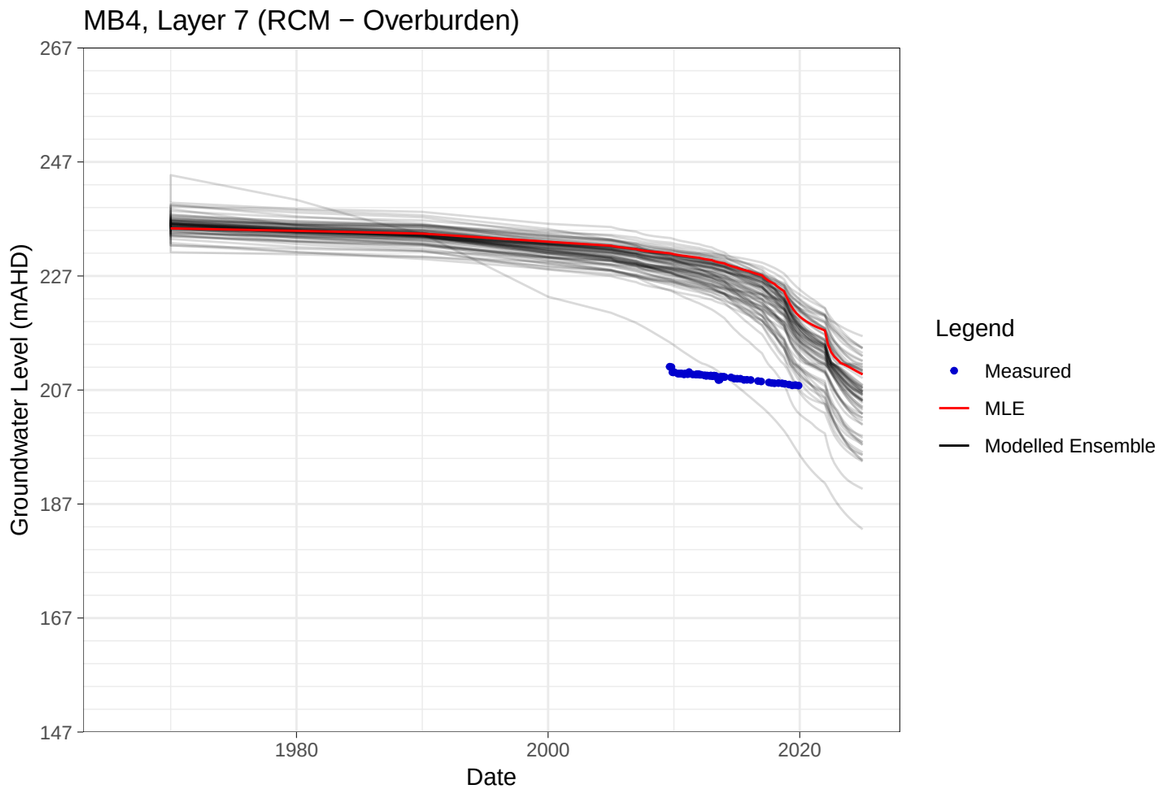

MB15, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
294
274
254
234
214
194
174
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

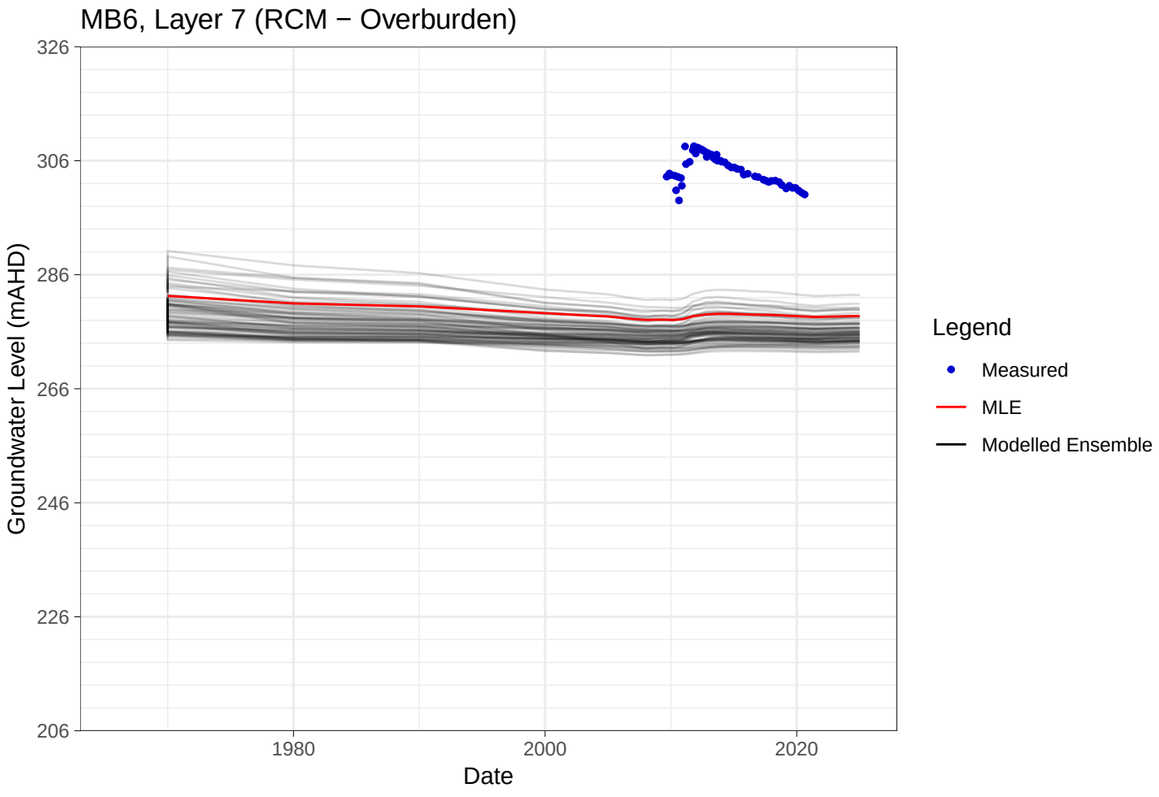

MB16, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
293
273
253
233
213
193
173
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

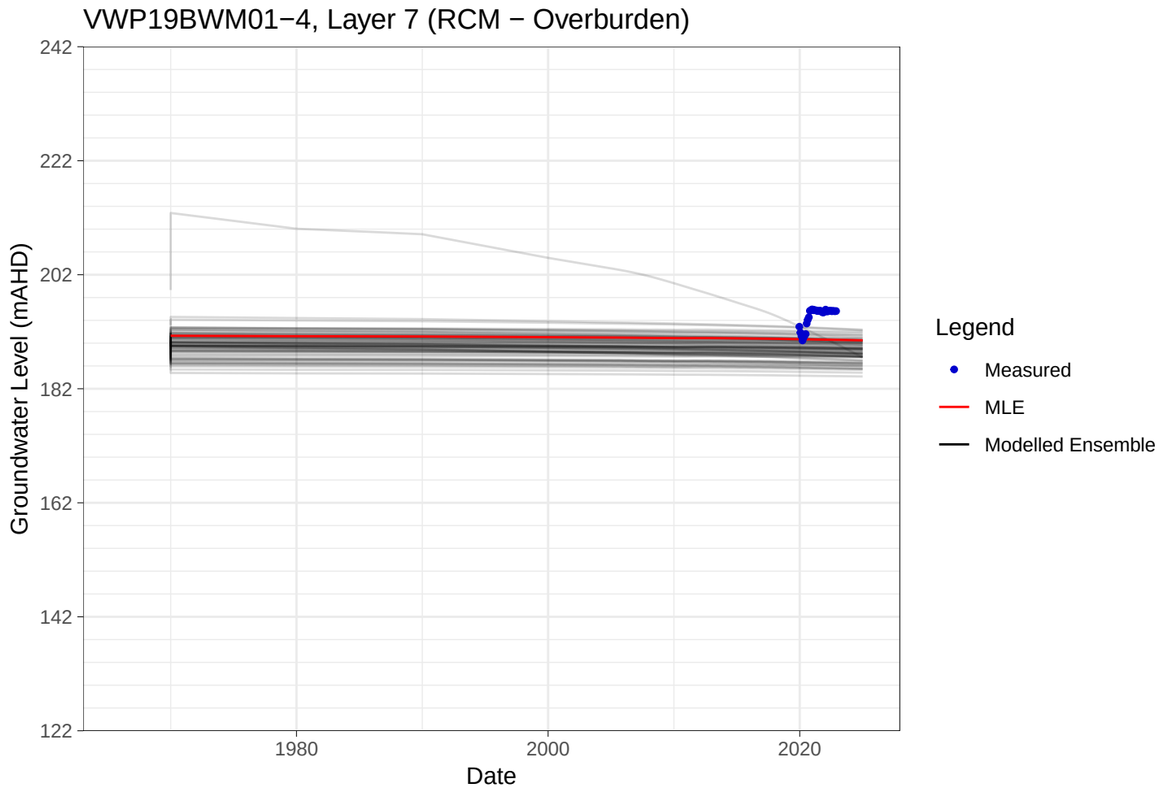

MB17, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
337
297
257
217
177
137
97
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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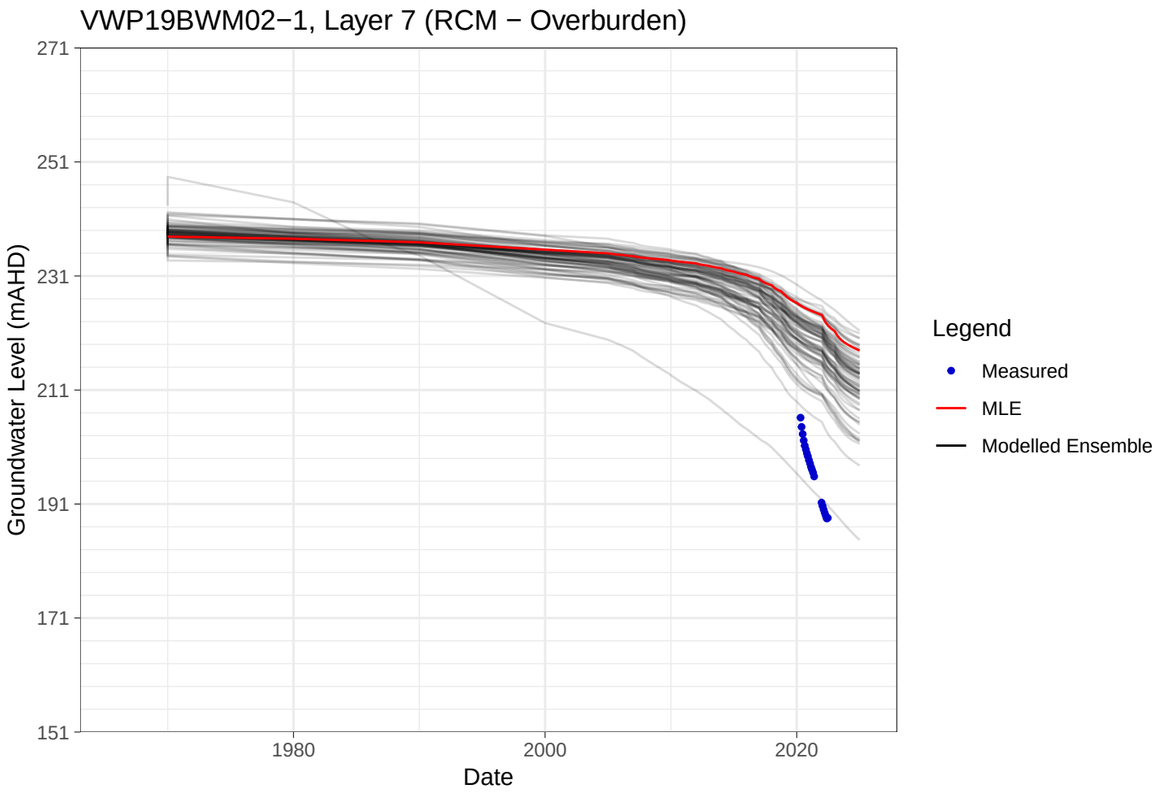

MB18, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
321
281
241
201
161
121
81
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

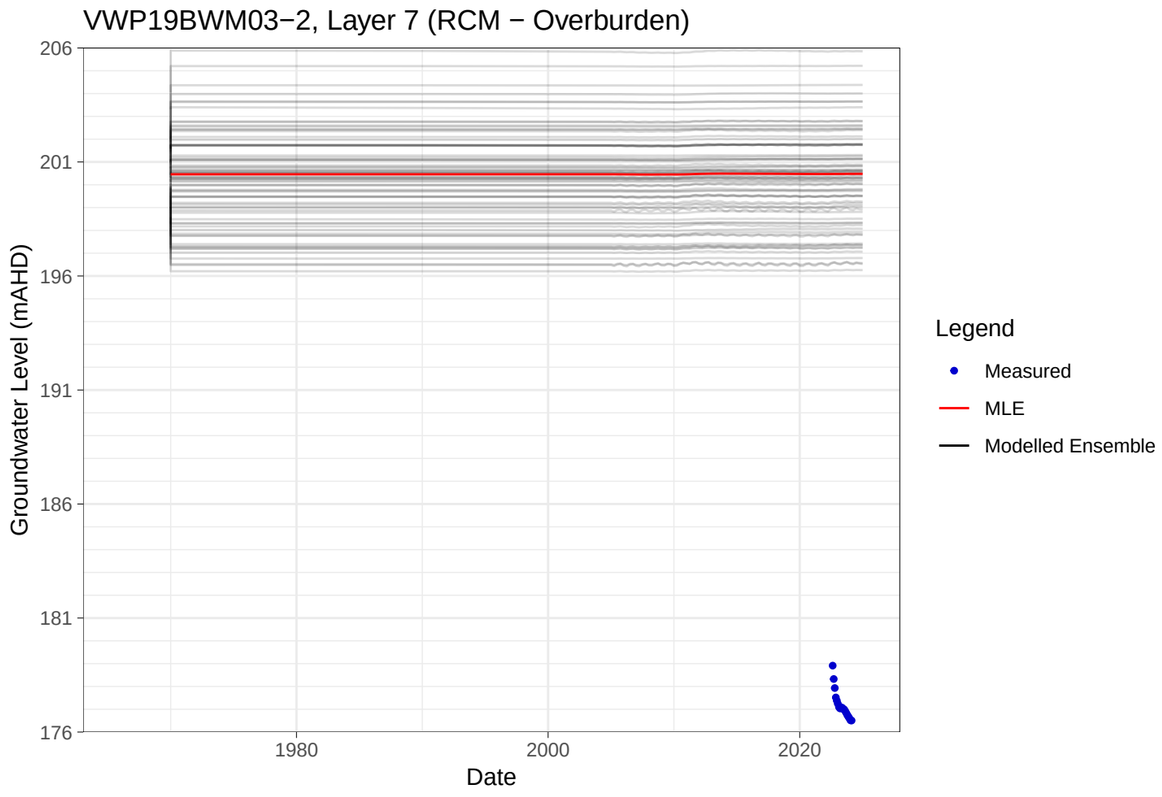

MB4, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
267
247
227
207
187
167
147
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

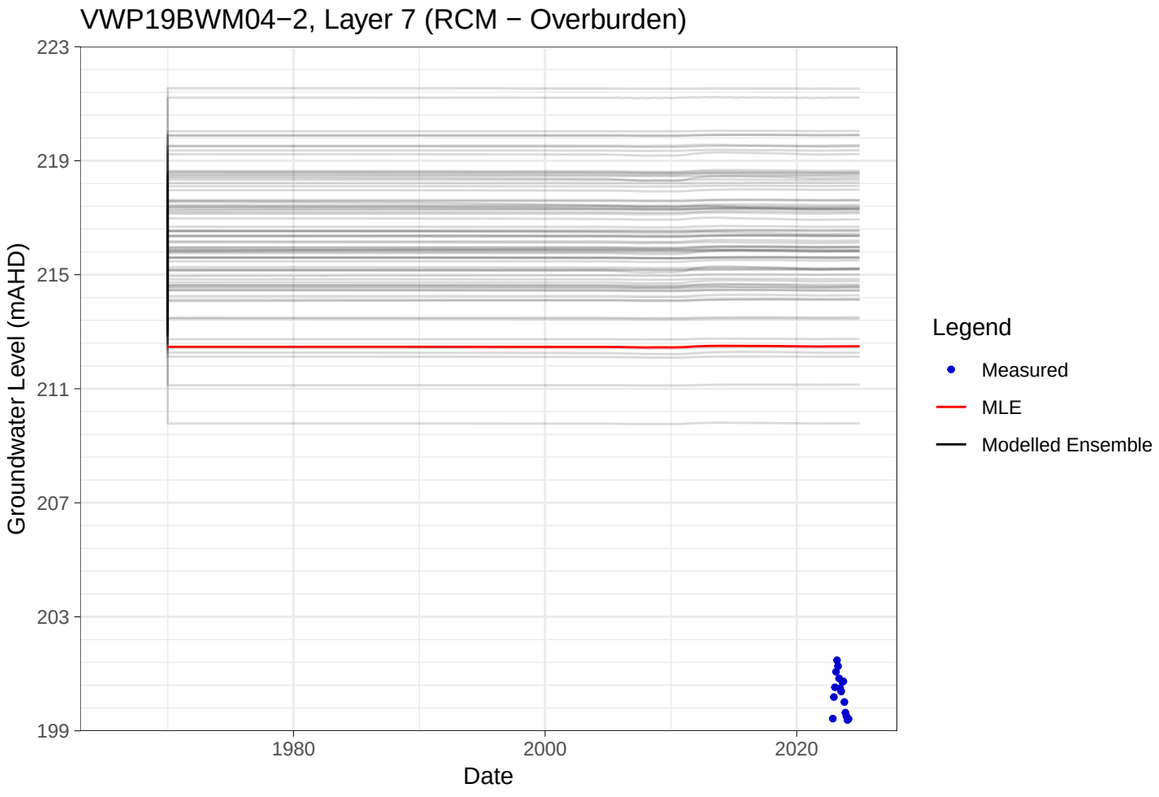

MB6, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
326
306
286
266
246
226
206
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

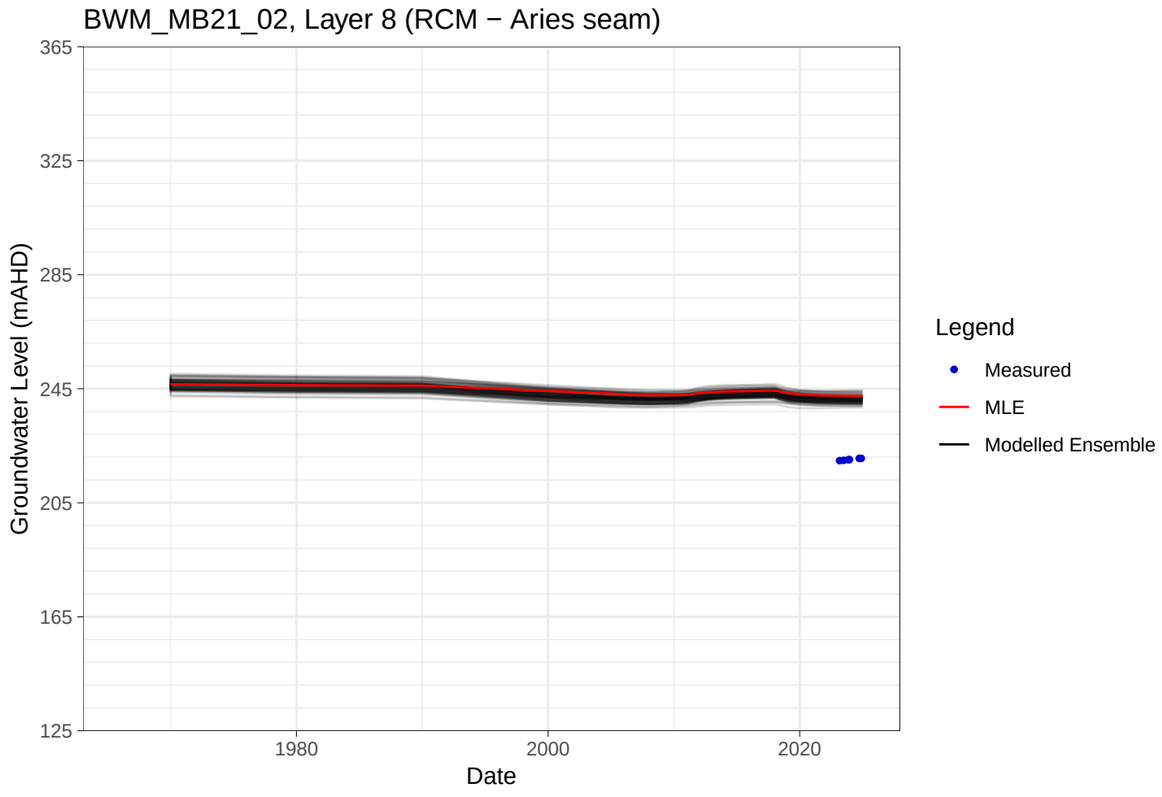

VWP19BWM01−4, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
242
222
202
182
162
142
122
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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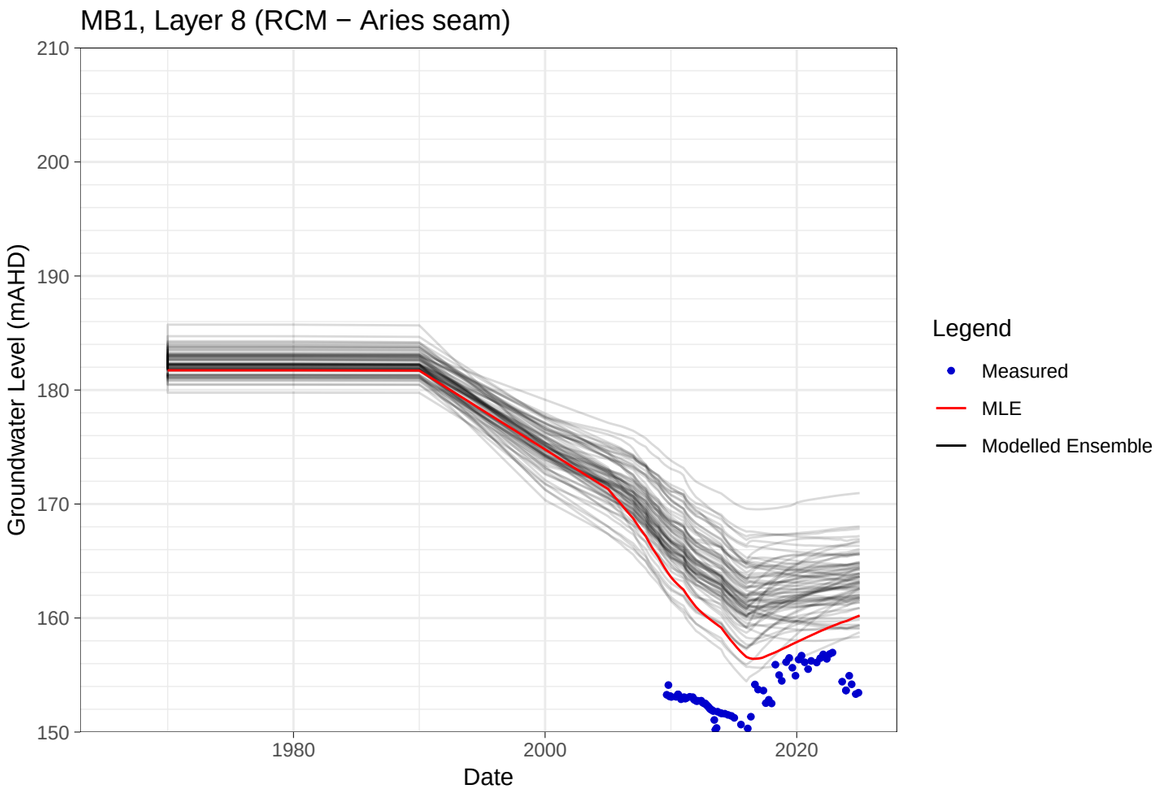

VWP19BWM02−1, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
271
251
231
211
191
171
151
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

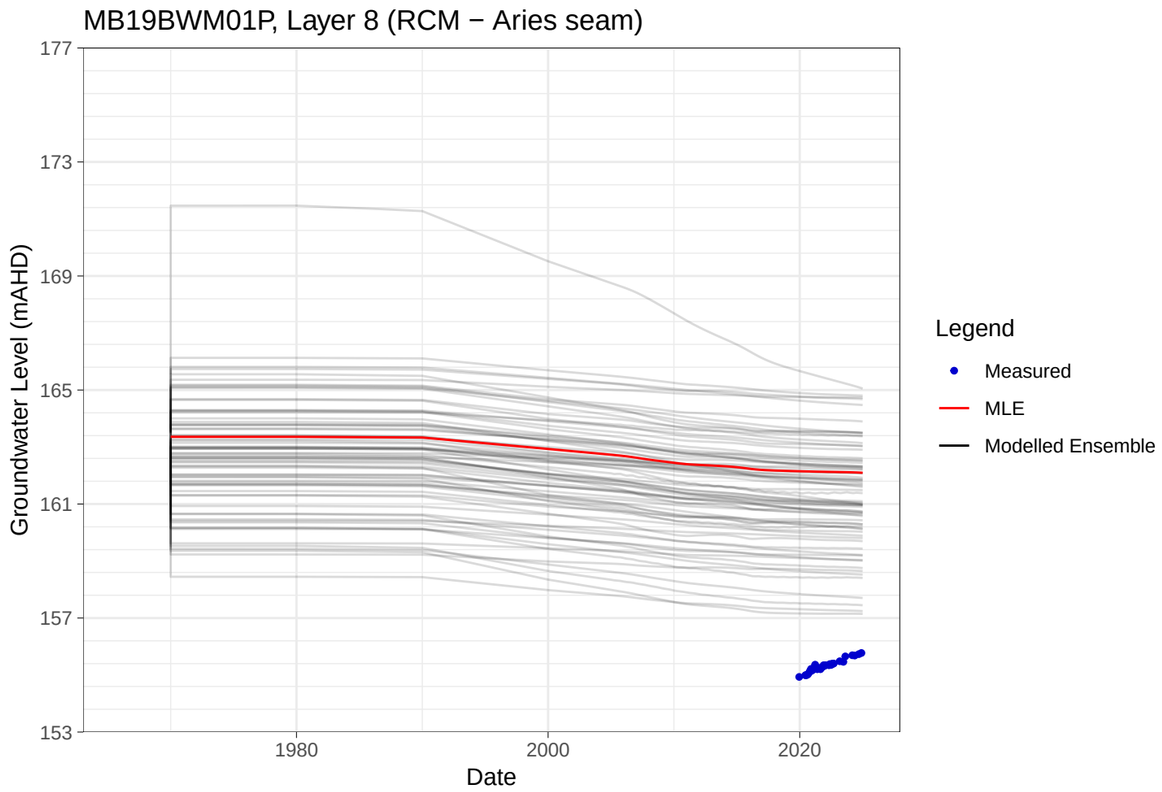

VWP19BWM03−2, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
206
201
196
191
186
181
176
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

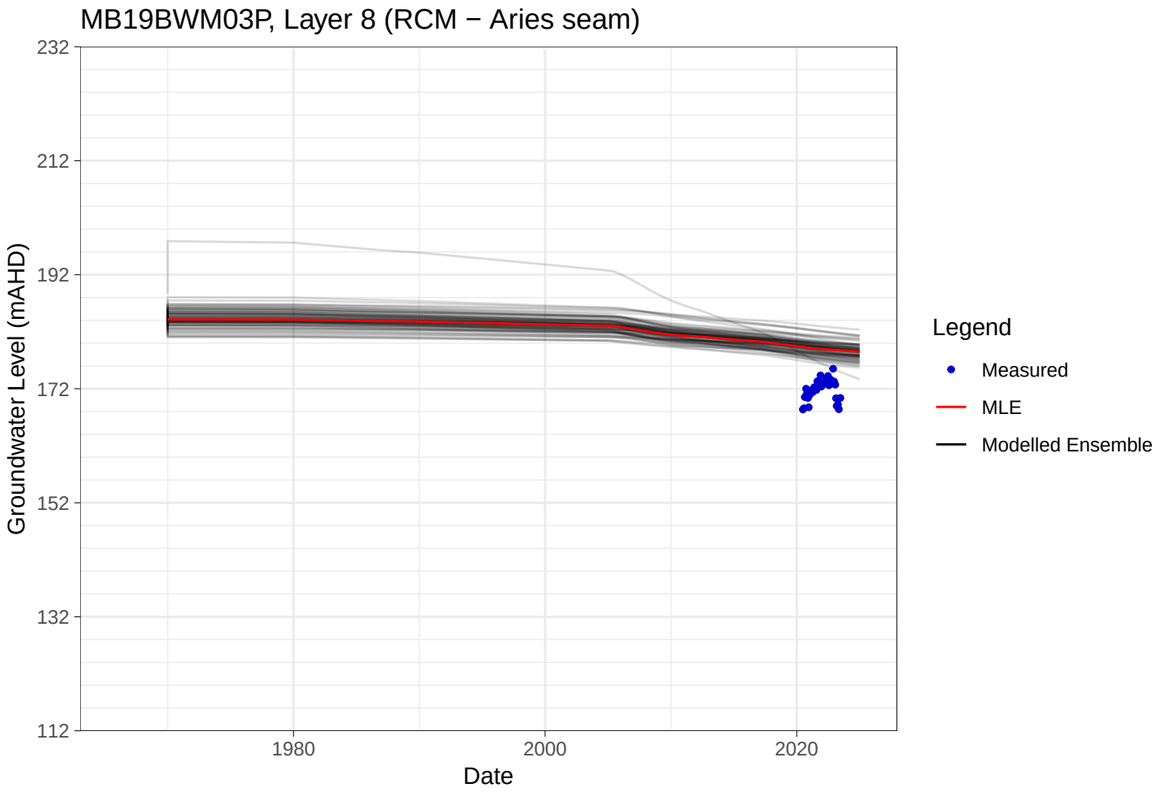

VWP19BWM04−2, Layer 7 (RCM − Overburden)
Groundwater Level (mAHD)
223
219
215
211
207
203
199
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

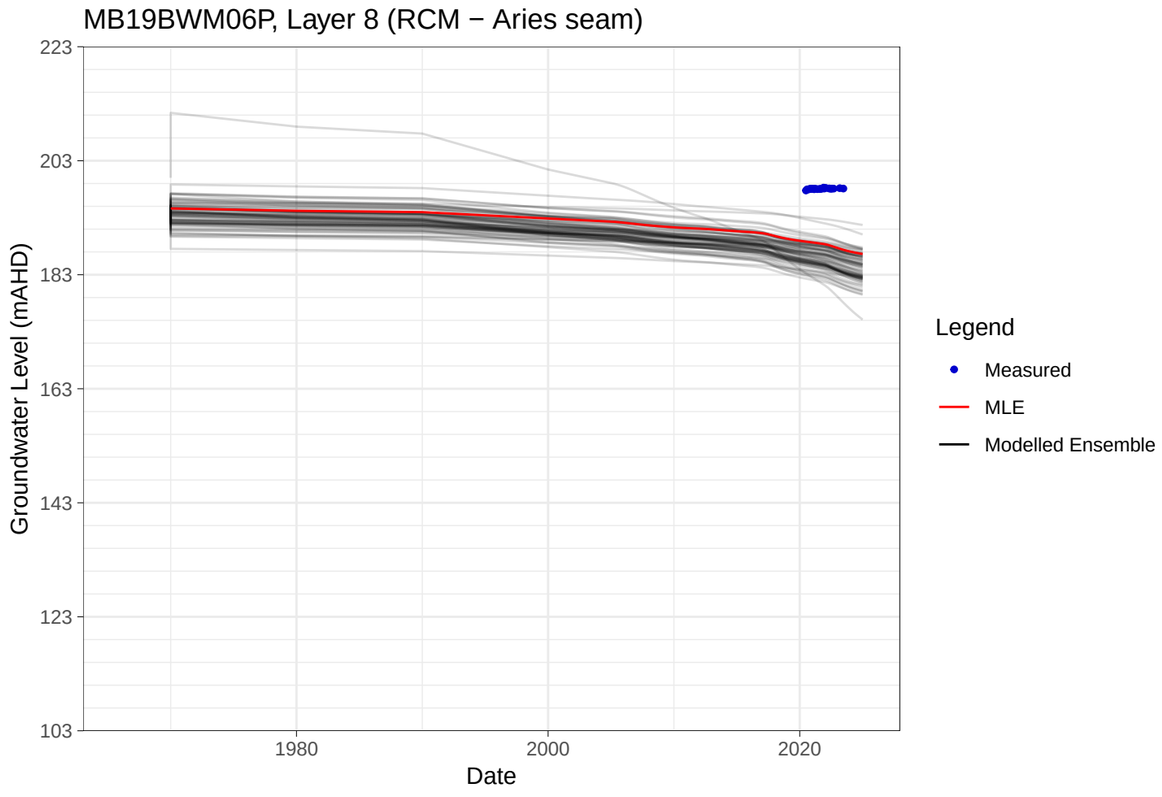

BWM_MB21_02, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
365
325
285
245
205
165
125
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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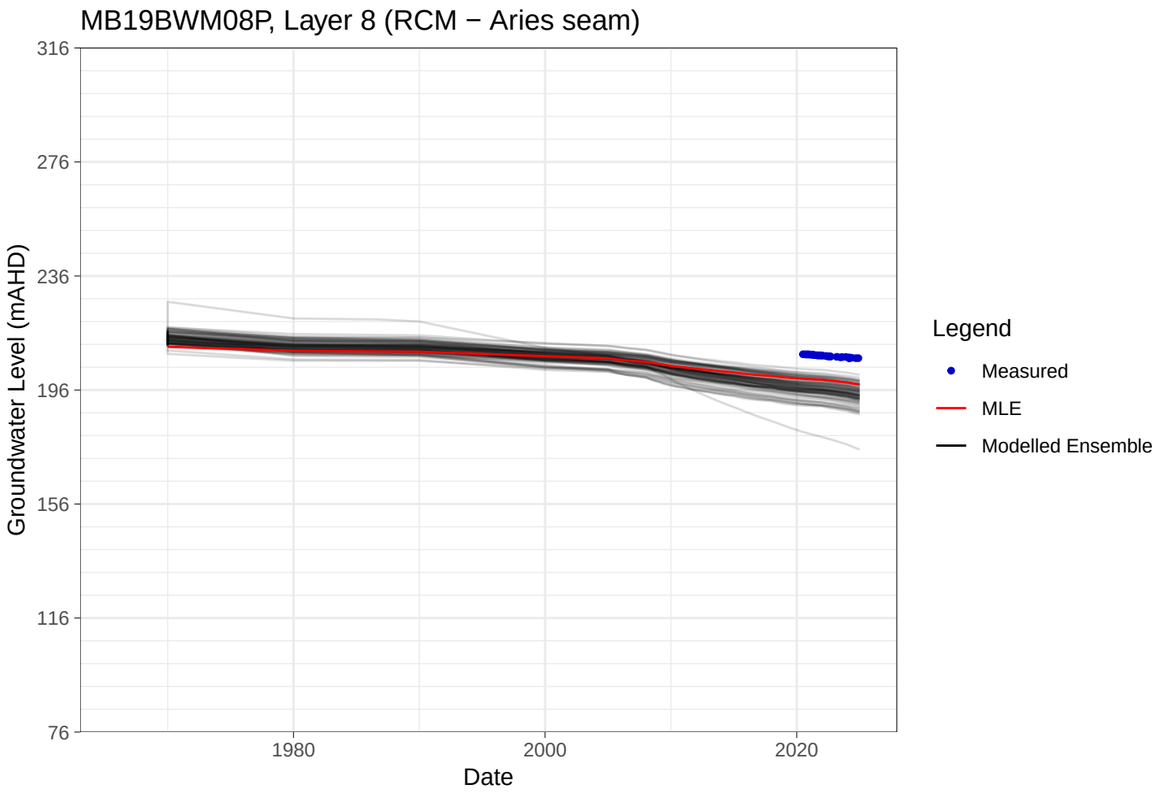

MB1, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
210
200
190
180
170
160
150
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

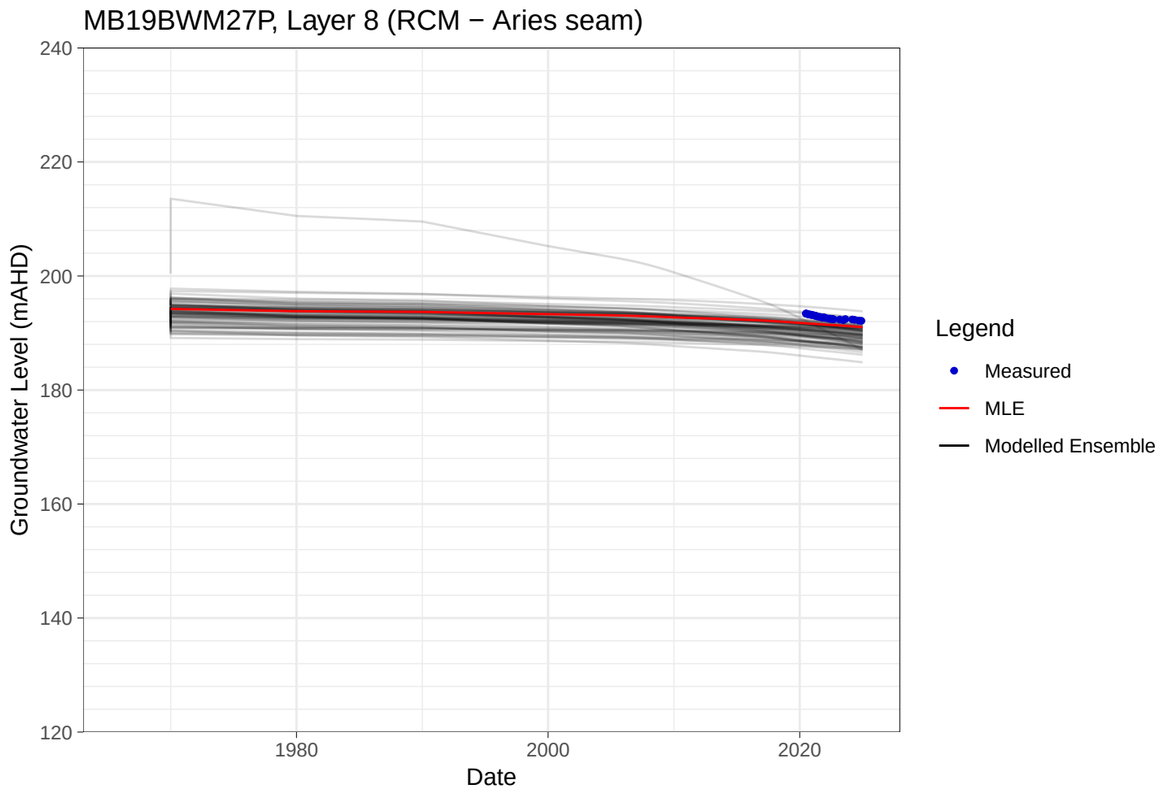

MB19BWM01P, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
177
173
169
165
161
157
153
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

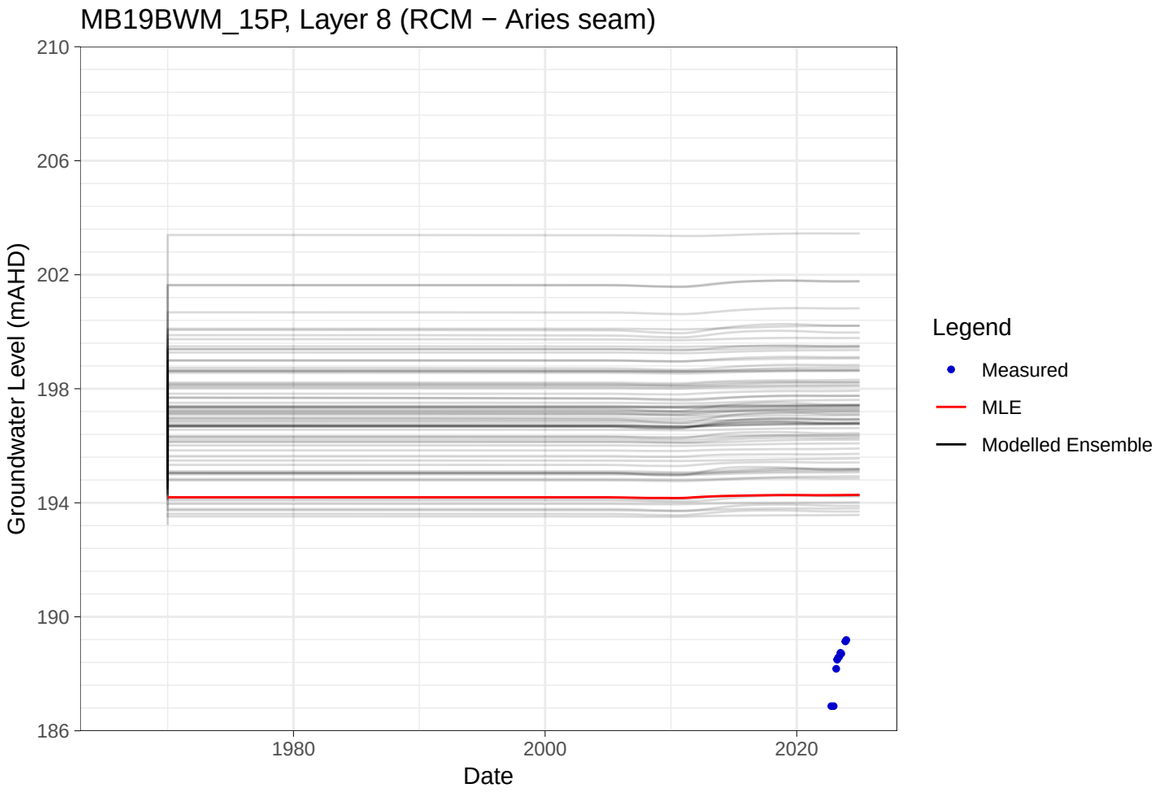

MB19BWM03P, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
232
212
192
172
152
132
112
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

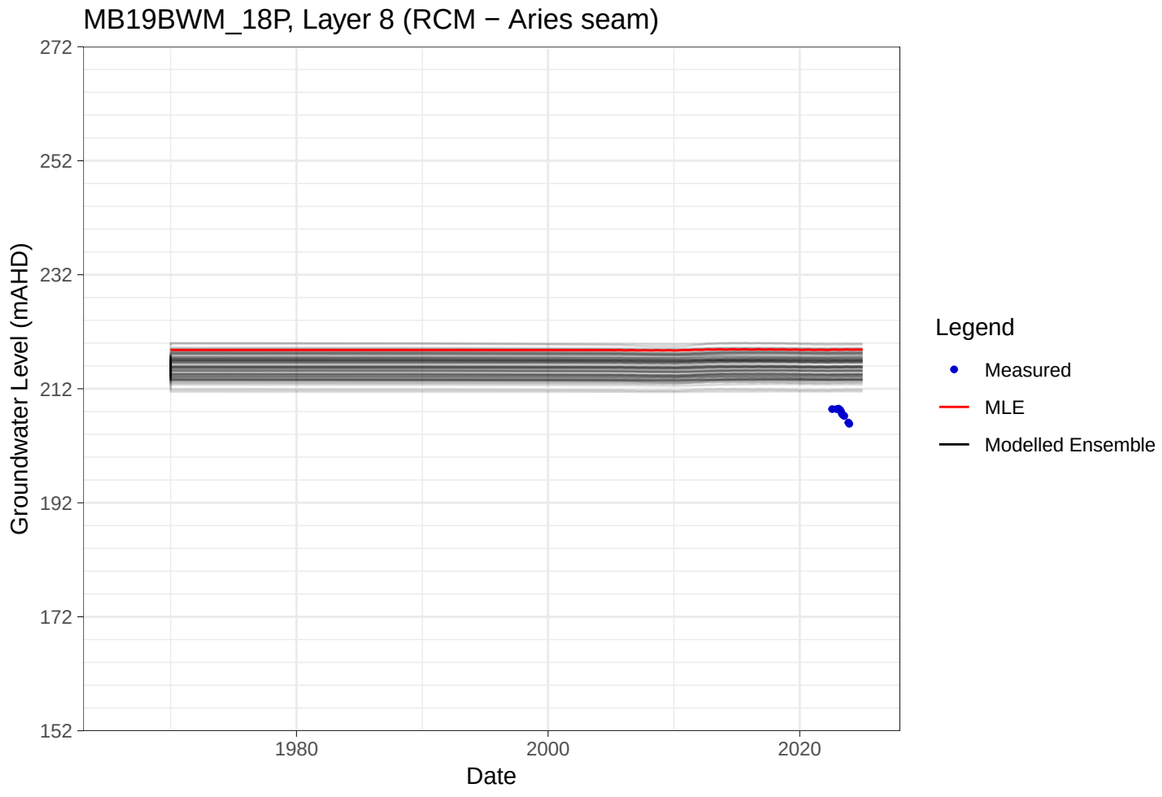

MB19BWM06P, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
223
203
183
163
143
123
103
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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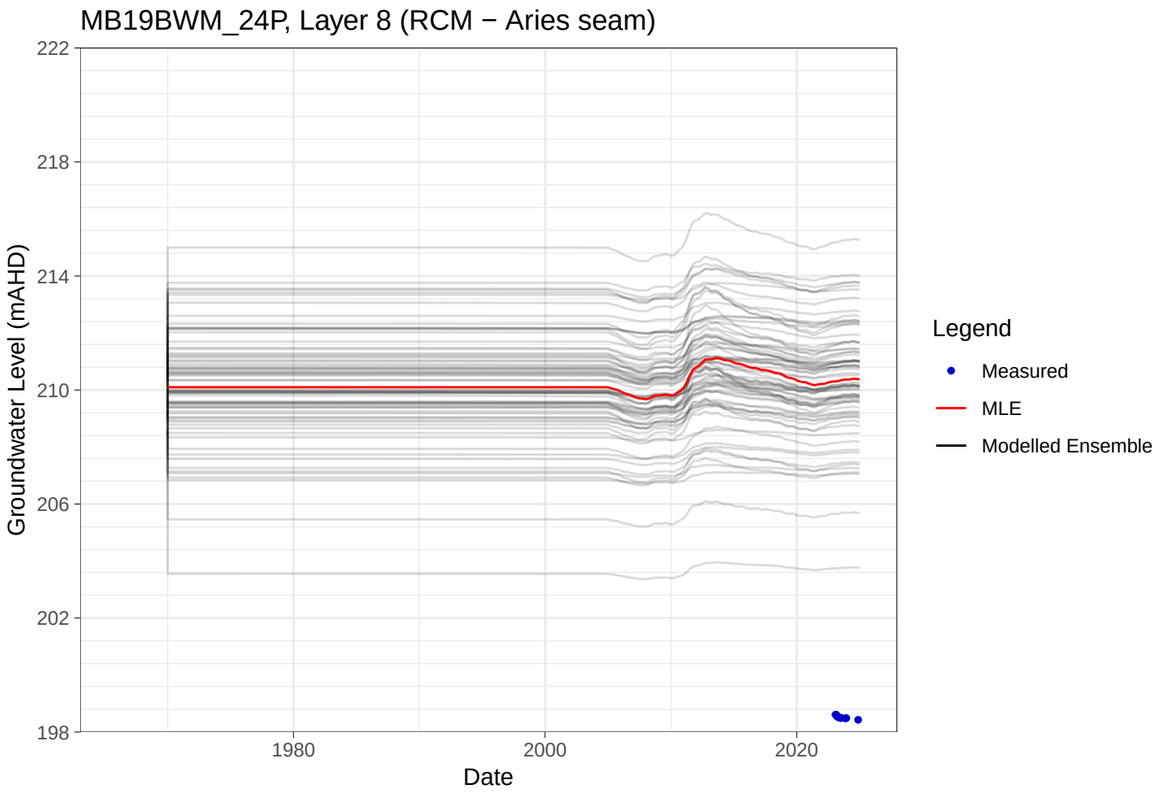

MB19BWM08P, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
316
276
236
196
156
116
76
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

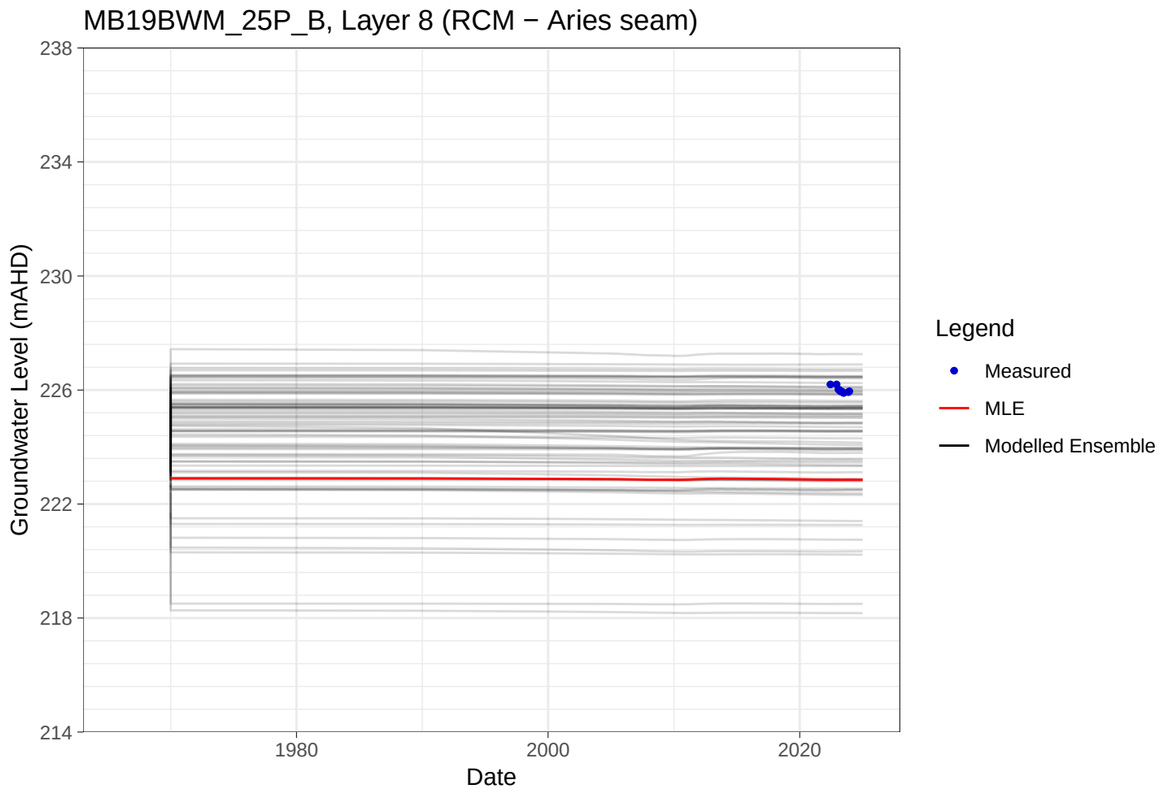

MB19BWM27P, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
240
220
200
180
160
140
120
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

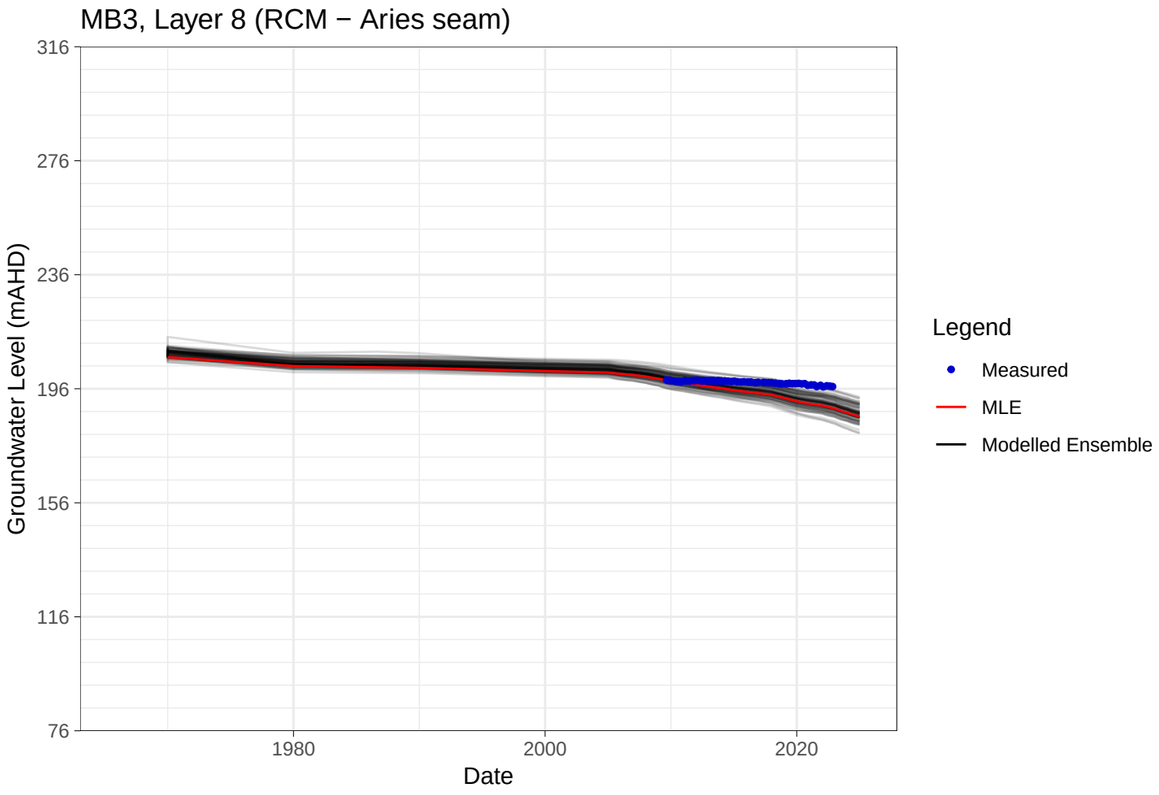

MB19BWM_15P, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
210
206
202
198
194
190
186
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

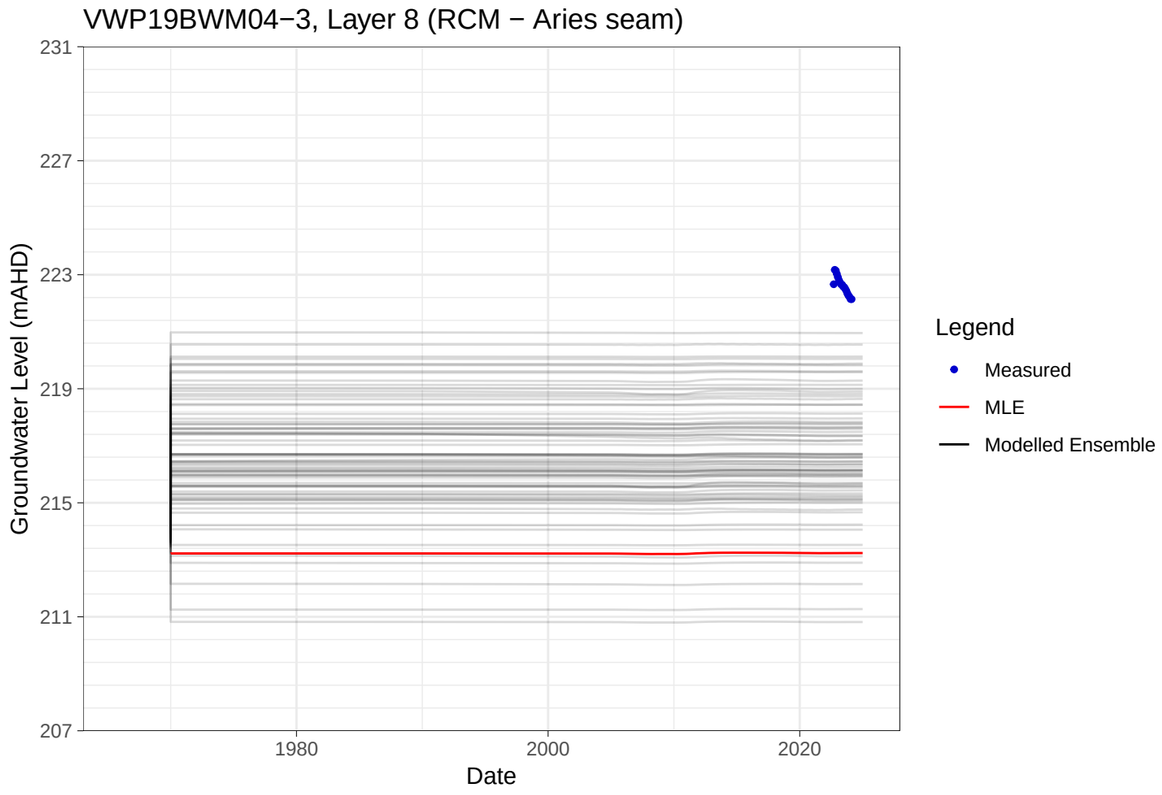

MB19BWM_18P, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
272
252
232
212
192
172
152
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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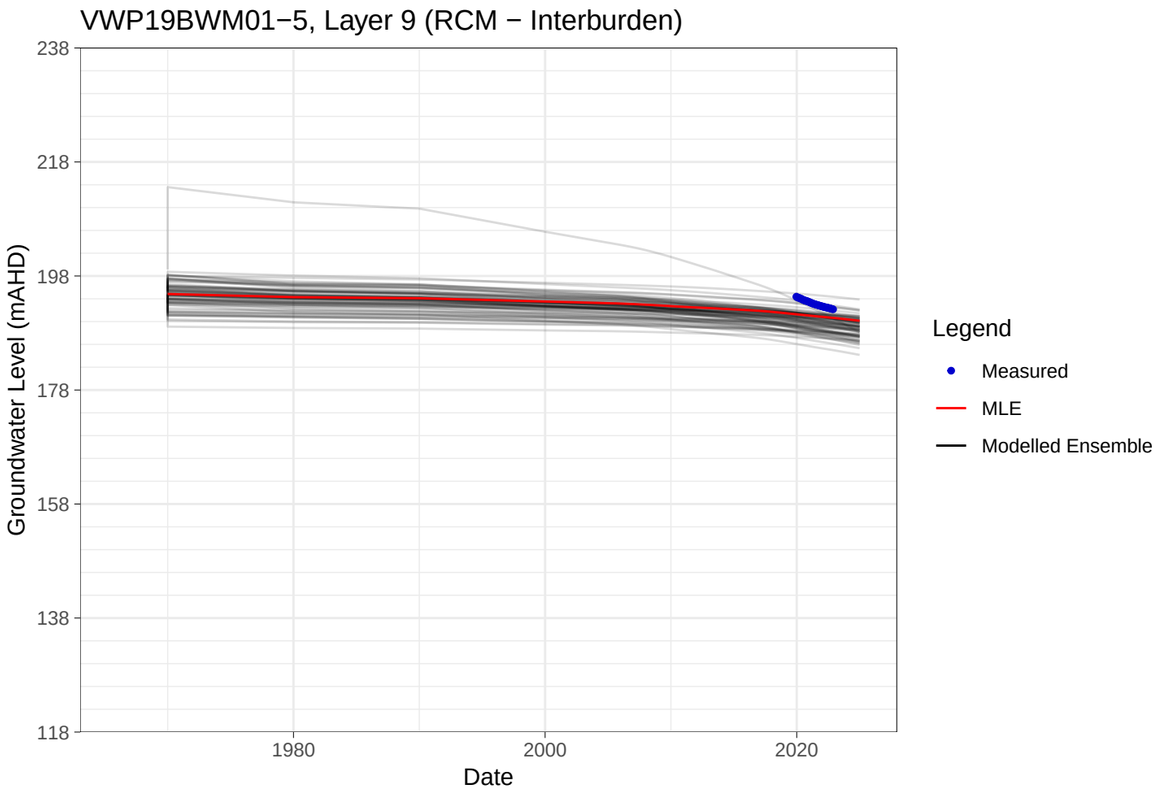

MB19BWM_24P, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
222
218
214
210
206
202
198
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

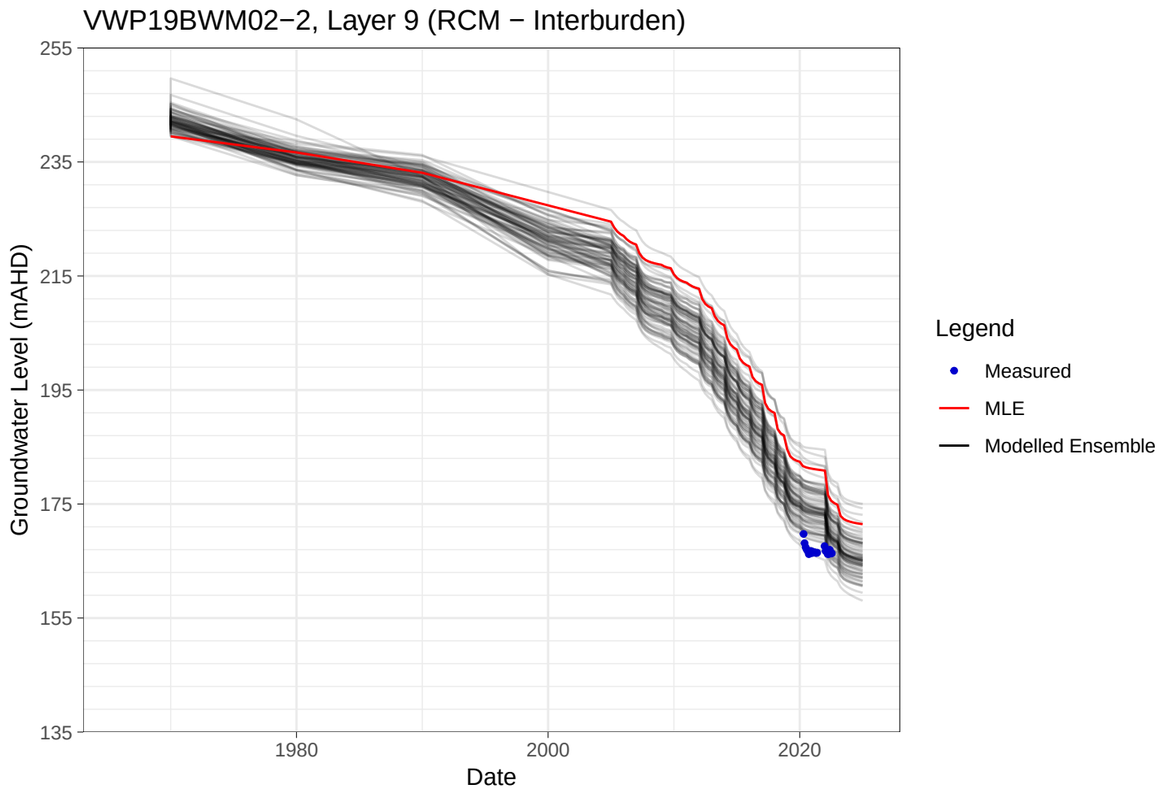

MB19BWM_25P_B, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
238
234
230
226
222
218
214
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

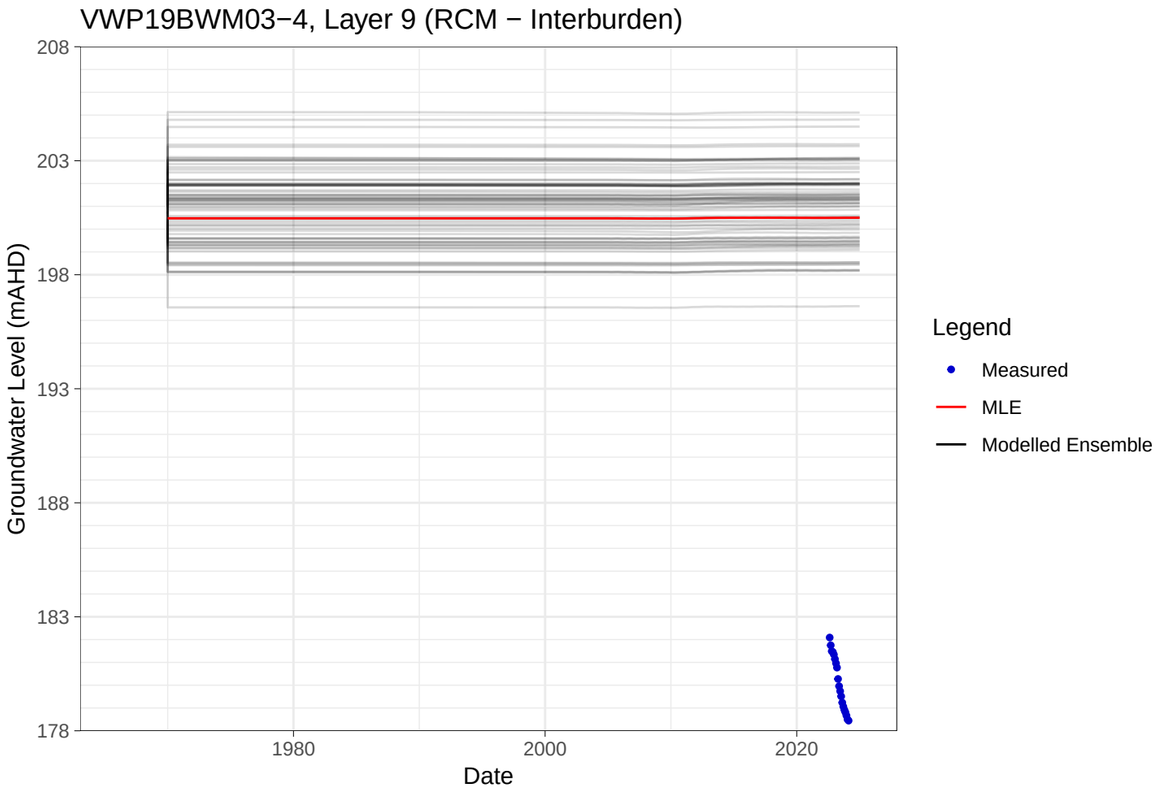

MB3, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
316
276
236
196
156
116
76
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

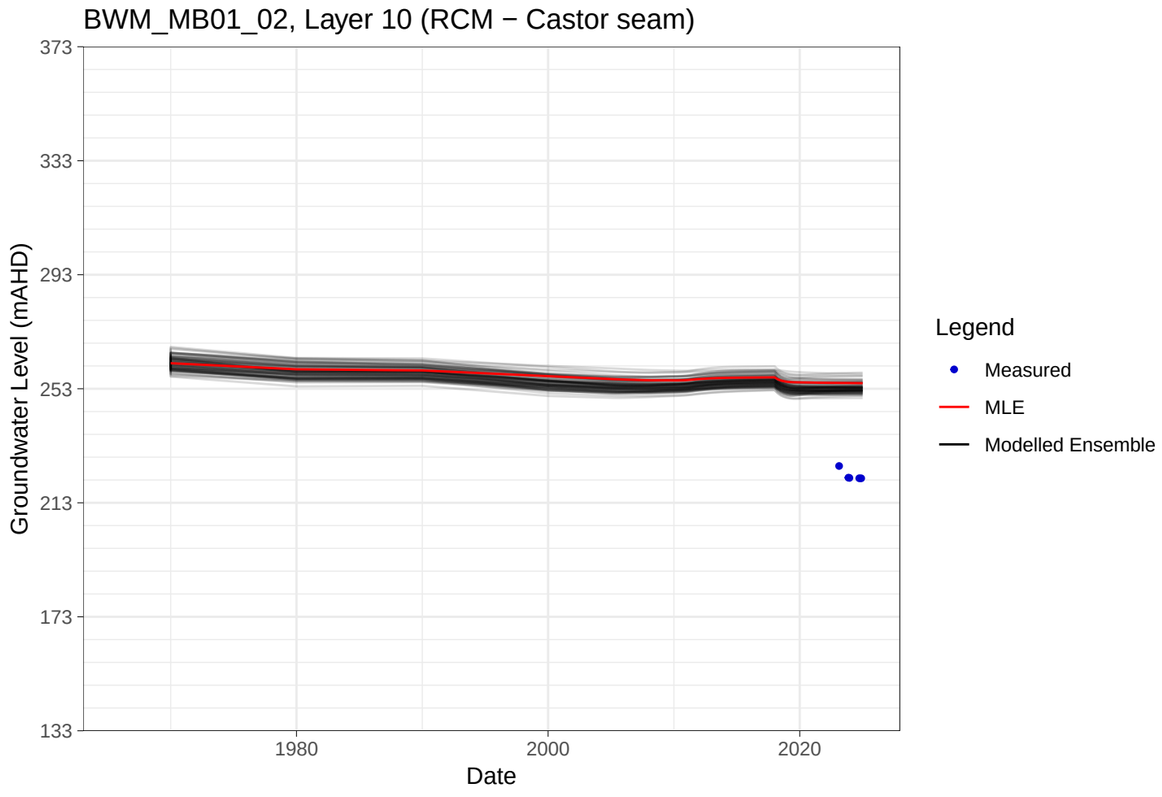

VWP19BWM04−3, Layer 8 (RCM − Aries seam)
Groundwater Level (mAHD)
231
227
223
219
215
211
207
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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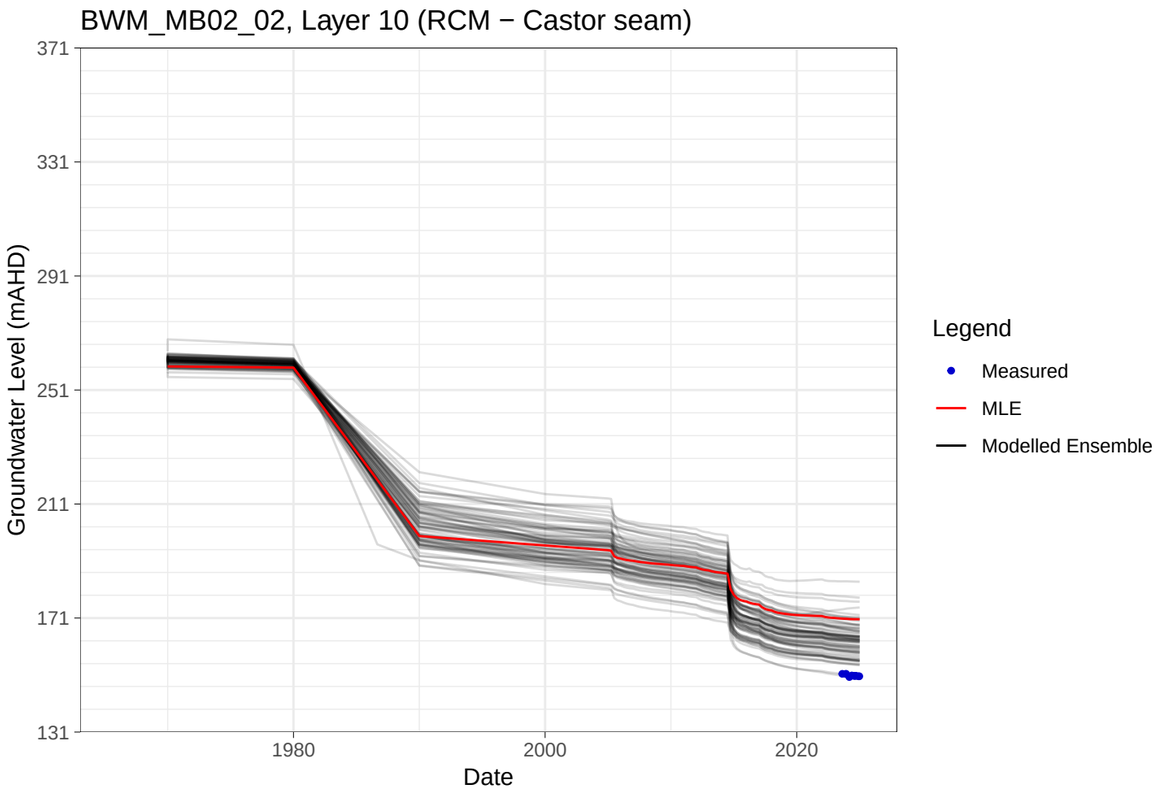

VWP19BWM01−5, Layer 9 (RCM − Interburden)
Groundwater Level (mAHD)
238
218
198
178
158
138
118
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

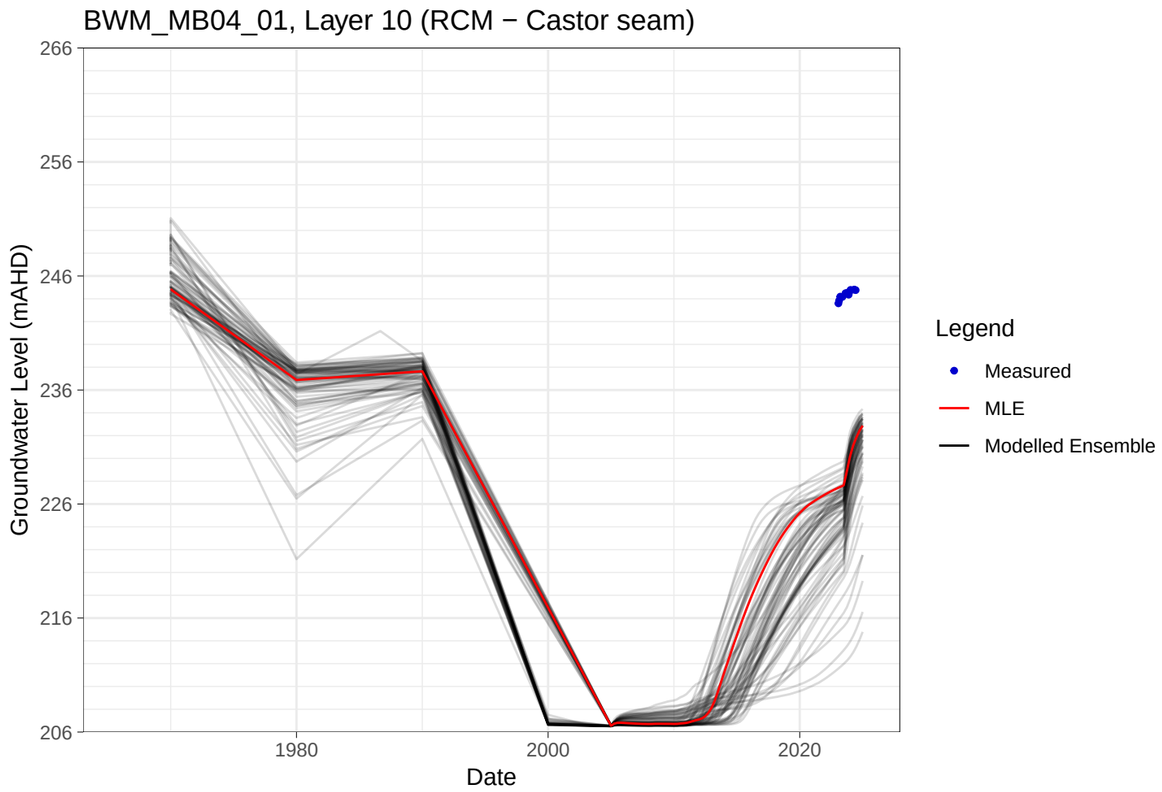

VWP19BWM02−2, Layer 9 (RCM − Interburden)
Groundwater Level (mAHD)
255
235
215
195
175
155
135
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

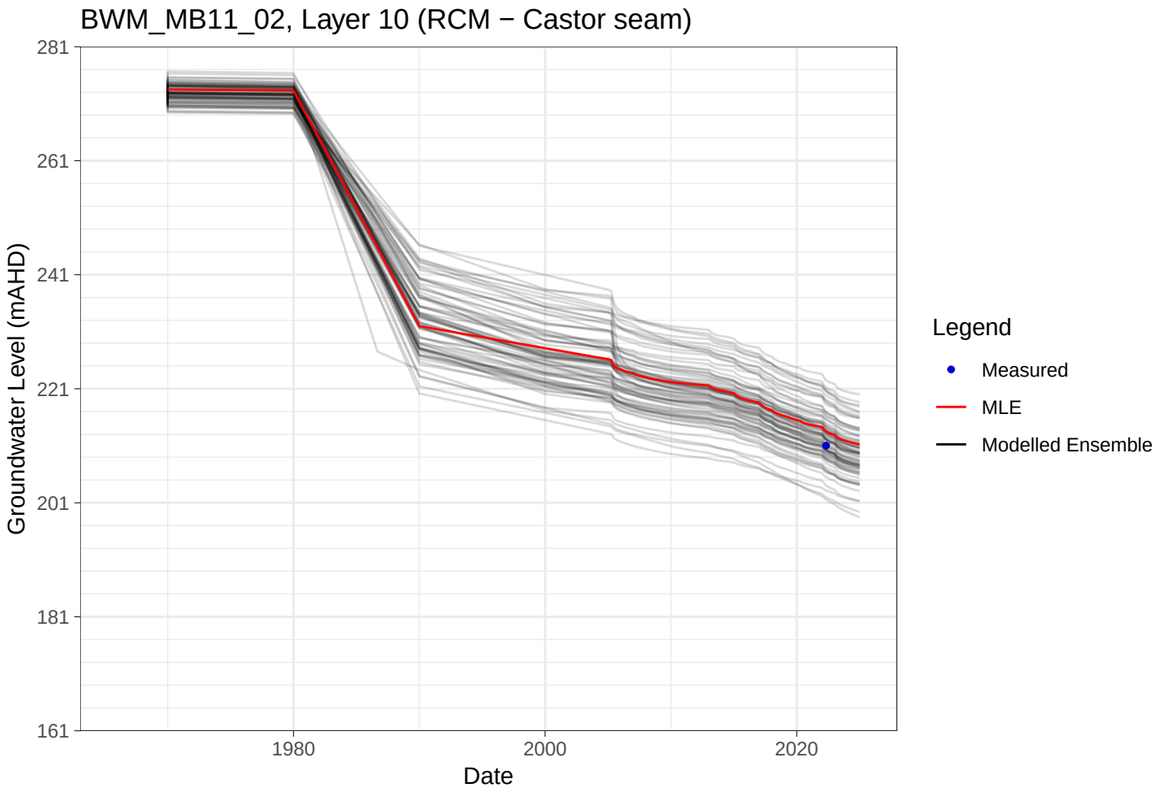

VWP19BWM03−4, Layer 9 (RCM − Interburden)
Groundwater Level (mAHD)
208
203
198
193
188
183
178
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

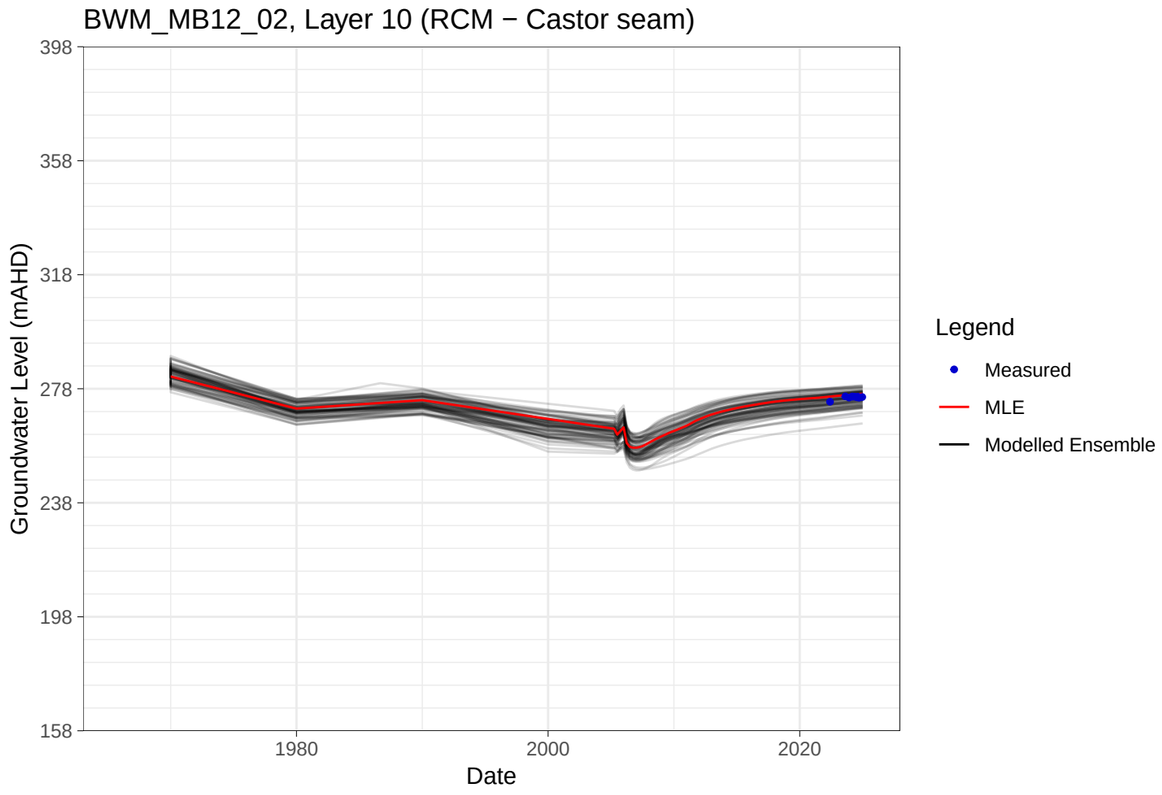

BWM_MB01_02, Layer 10 (RCM − Castor seam)
Groundwater Level (mAHD)
373
333
293
253
213
173
133
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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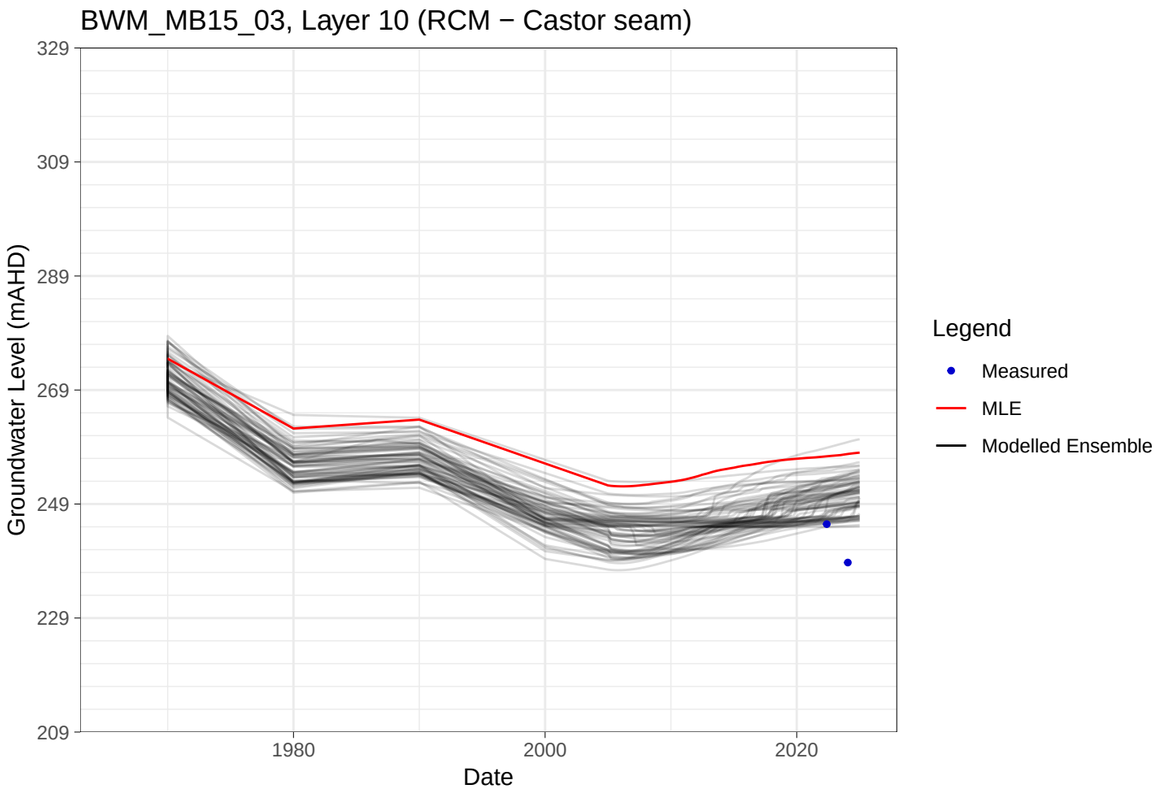

BWM_MB02_02, Layer 10 (RCM − Castor seam)
Groundwater Level (mAHD)
371
331
291
251
211
171
131
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

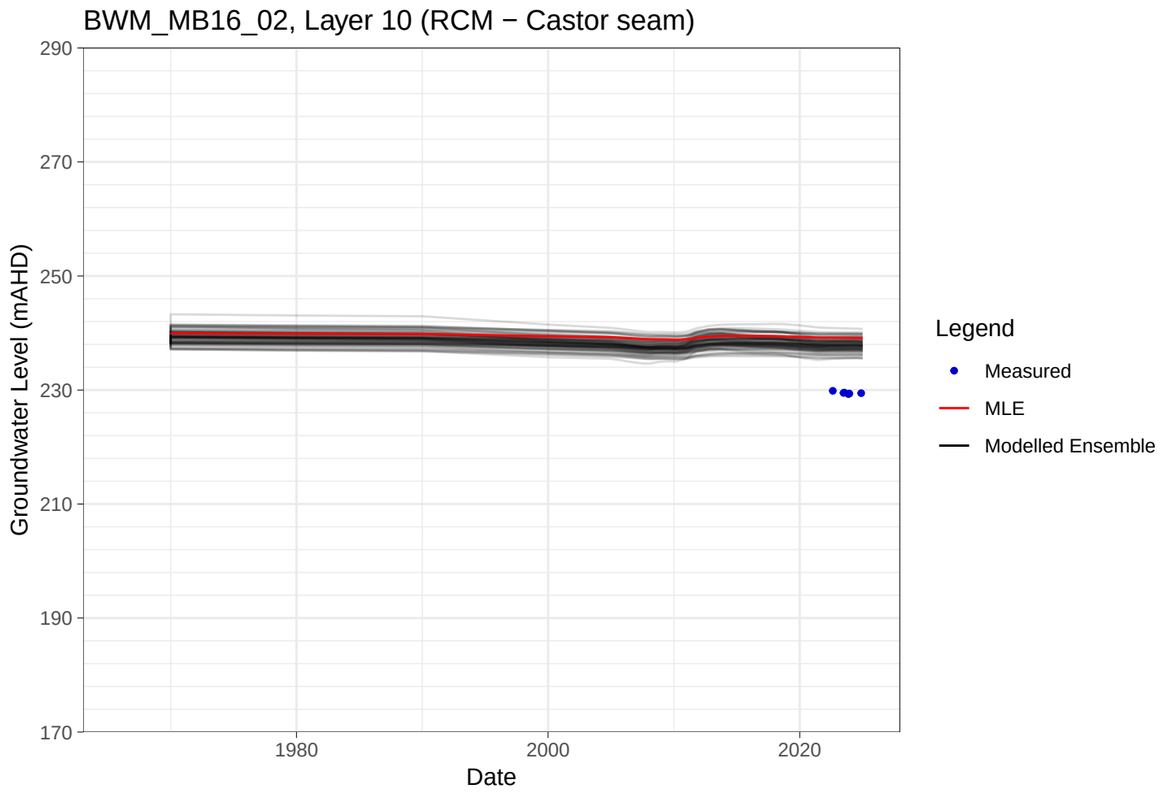

BWM_MB04_01, Layer 10 (RCM − Castor seam)
Groundwater Level (mAHD)
266
256
246
236
226
216
206
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

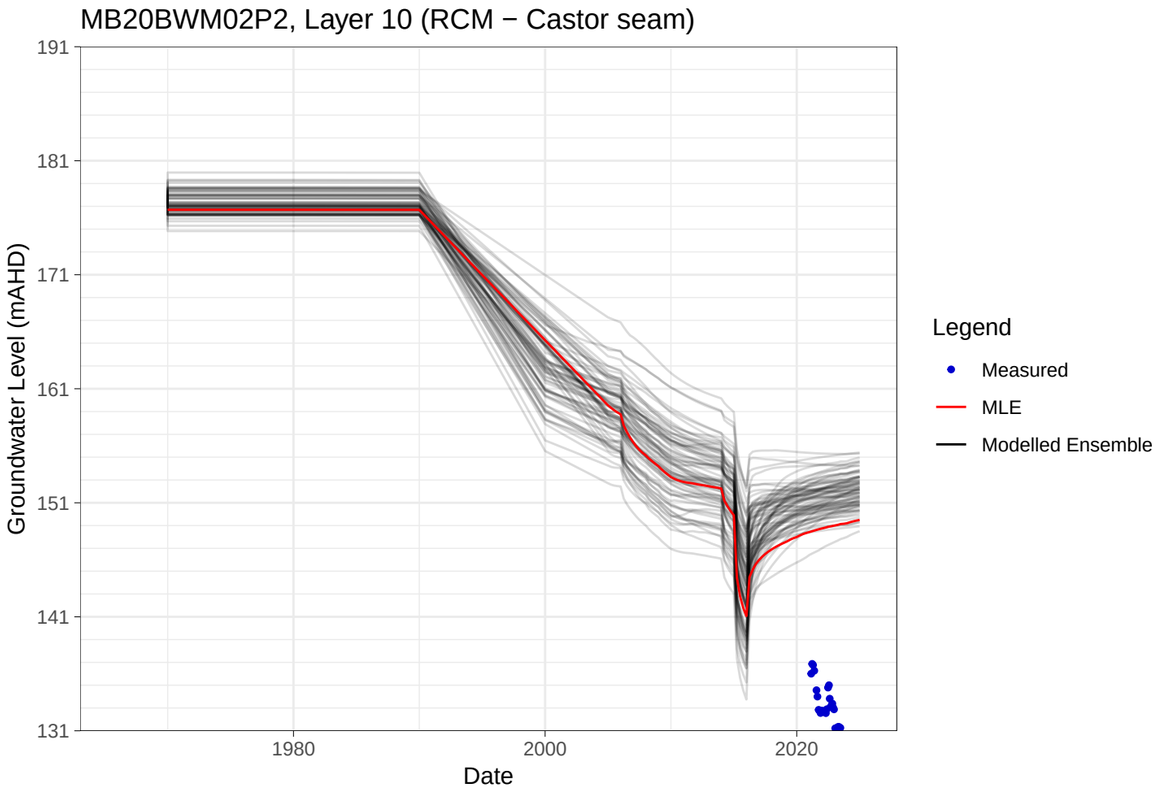

BWM_MB11_02, Layer 10 (RCM − Castor seam)
Groundwater Level (mAHD)
281
261
241
221
201
181
161
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

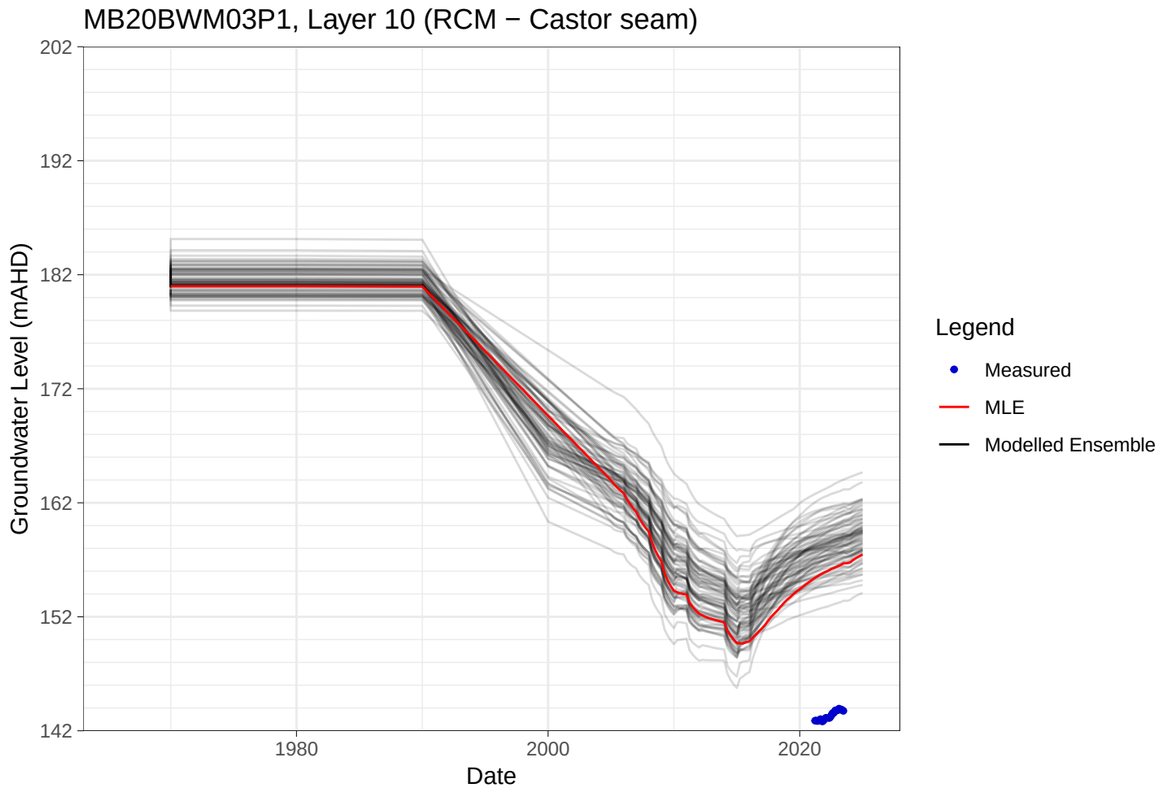

BWM_MB12_02, Layer 10 (RCM − Castor seam)
Groundwater Level (mAHD)
398
358
318
278
238
198
158
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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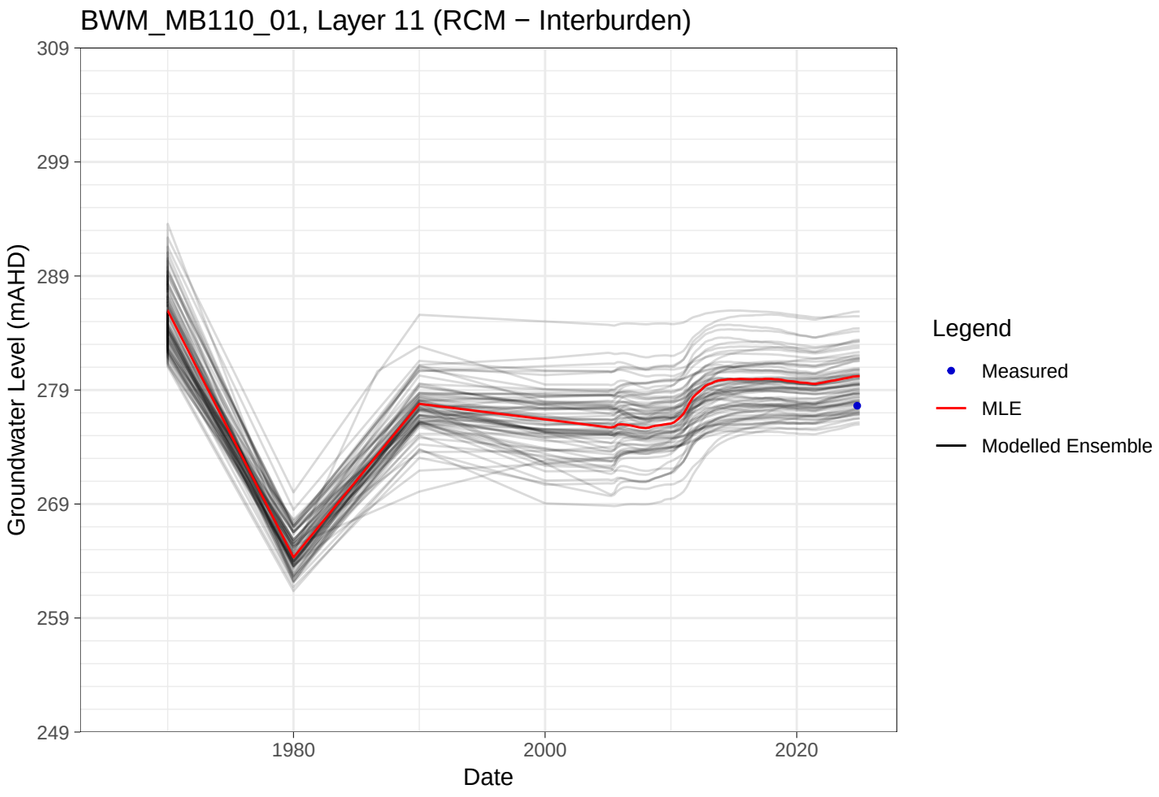

BWM_MB15_03, Layer 10 (RCM − Castor seam)
Groundwater Level (mAHD)
329
309
289
269
249
229
209
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

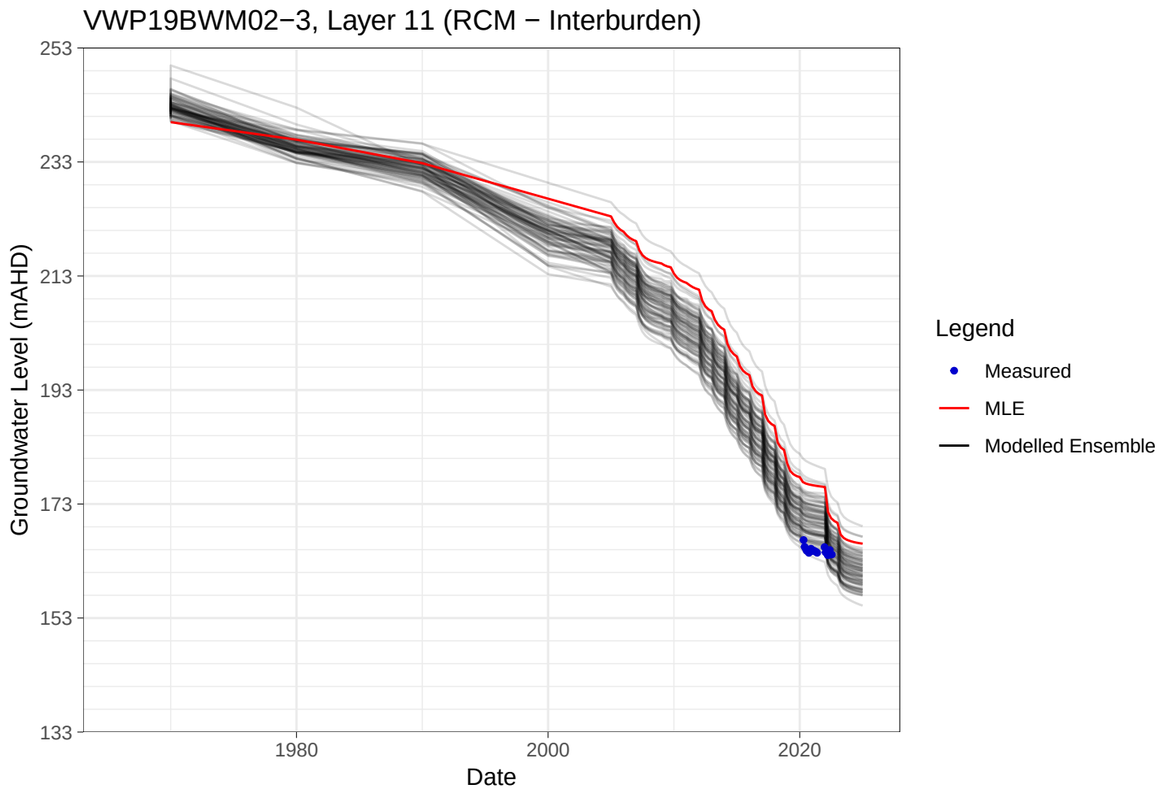

BWM_MB16_02, Layer 10 (RCM − Castor seam)
Groundwater Level (mAHD)
290
270
250
230
210
190
170
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

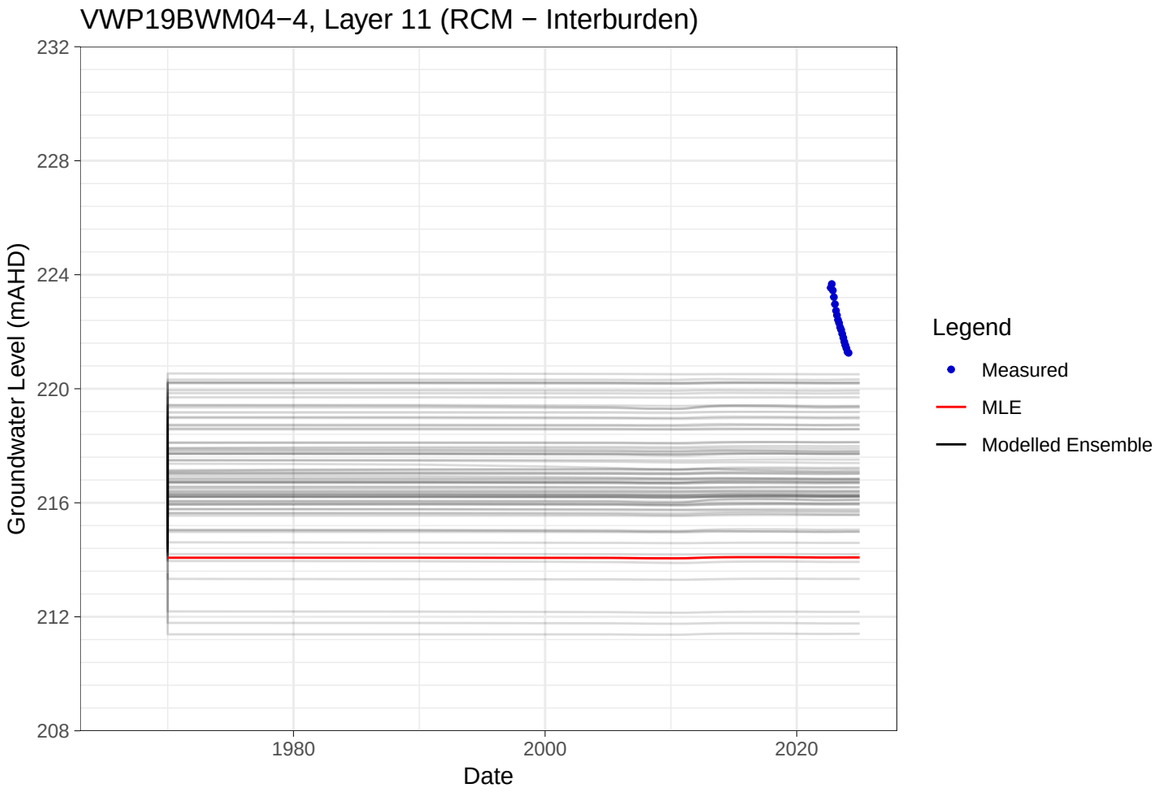

MB20BWM02P2, Layer 10 (RCM − Castor seam)
Groundwater Level (mAHD)
191
181
171
161
151
141
131
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

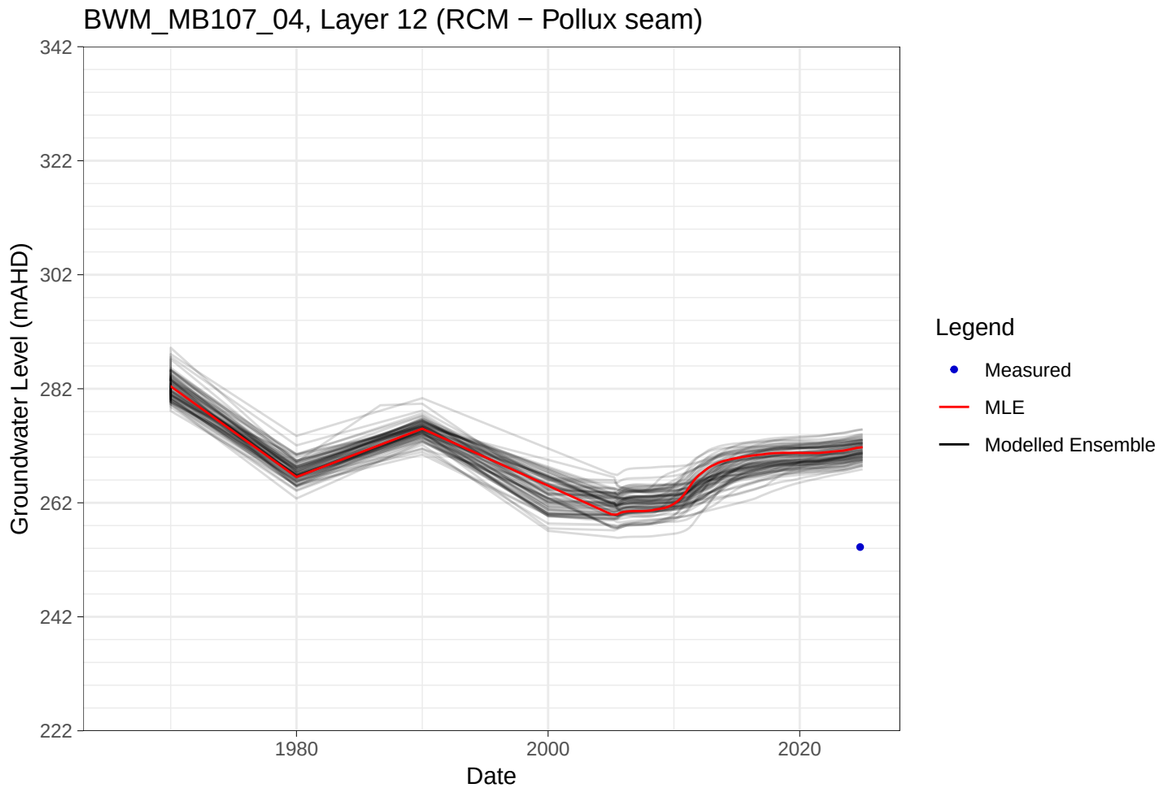

MB20BWM03P1, Layer 10 (RCM − Castor seam)
Groundwater Level (mAHD)
202
192
182
172
162
152
142
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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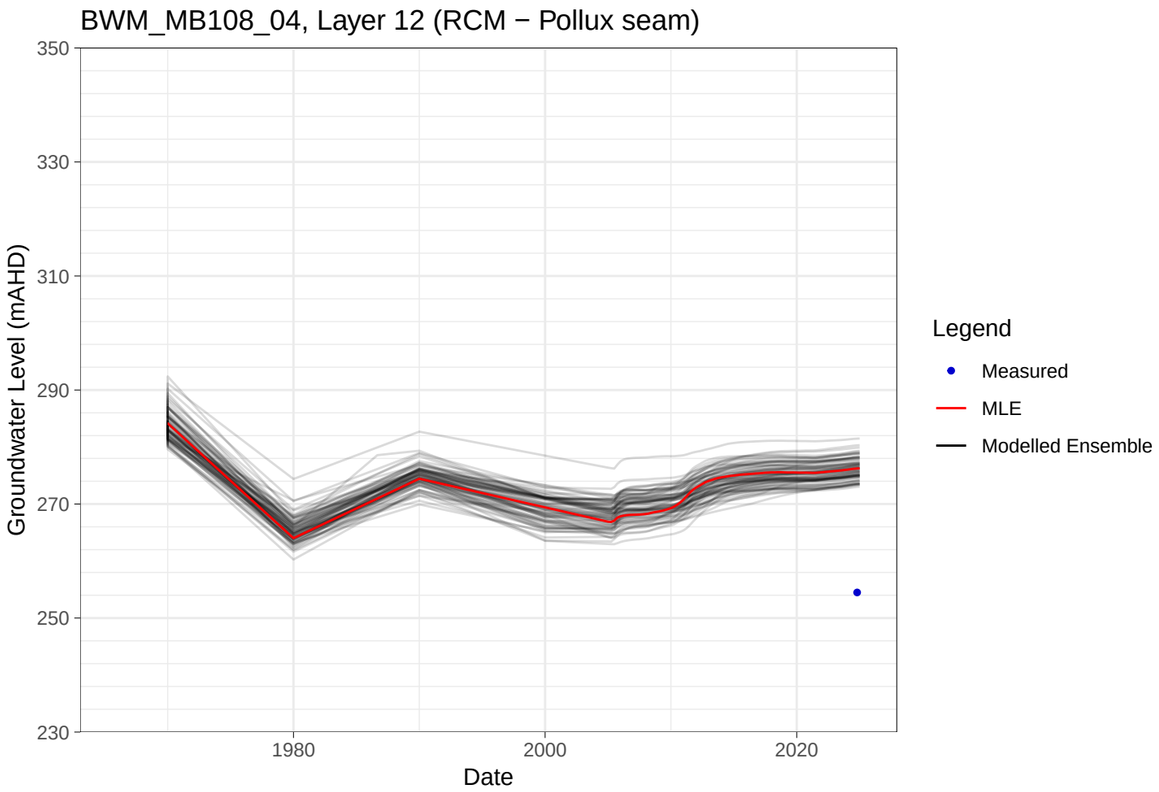

BWM_MB110_01, Layer 11 (RCM − Interburden)
Groundwater Level (mAHD)
309
299
289
279
269
259
249
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

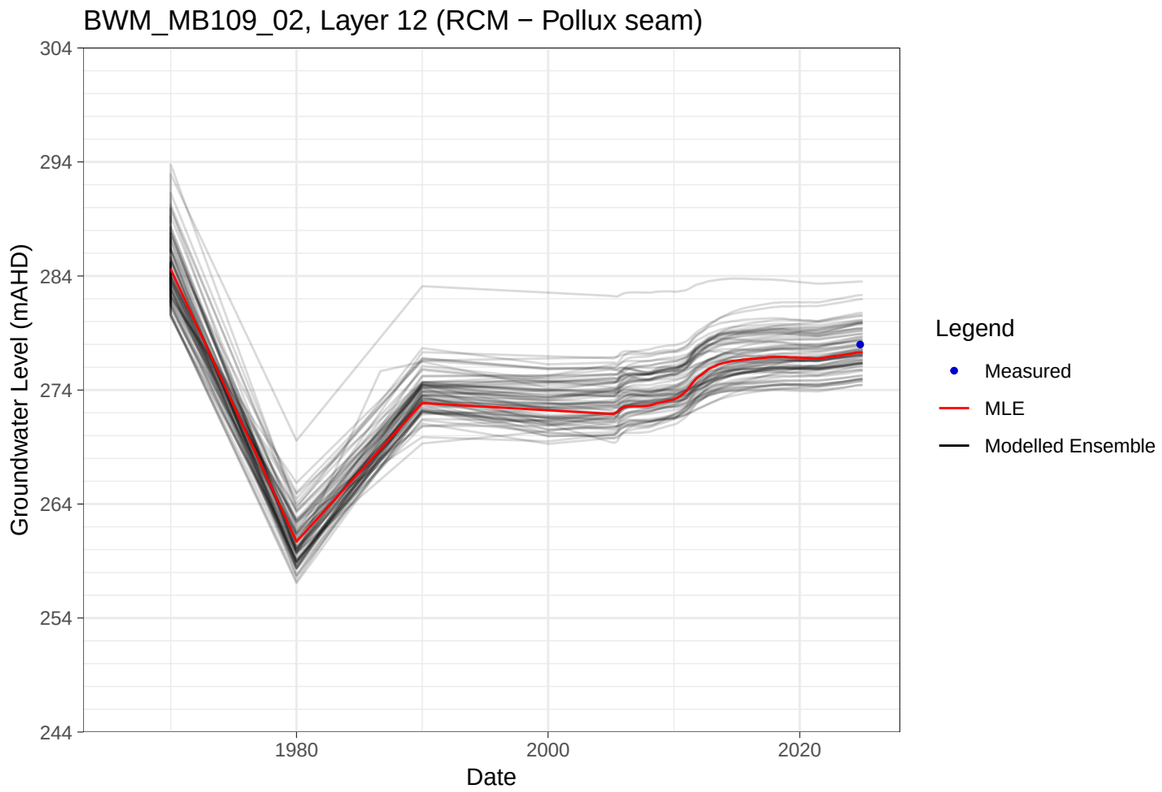

VWP19BWM02−3, Layer 11 (RCM − Interburden)
Groundwater Level (mAHD)
253
233
213
193
173
153
133
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

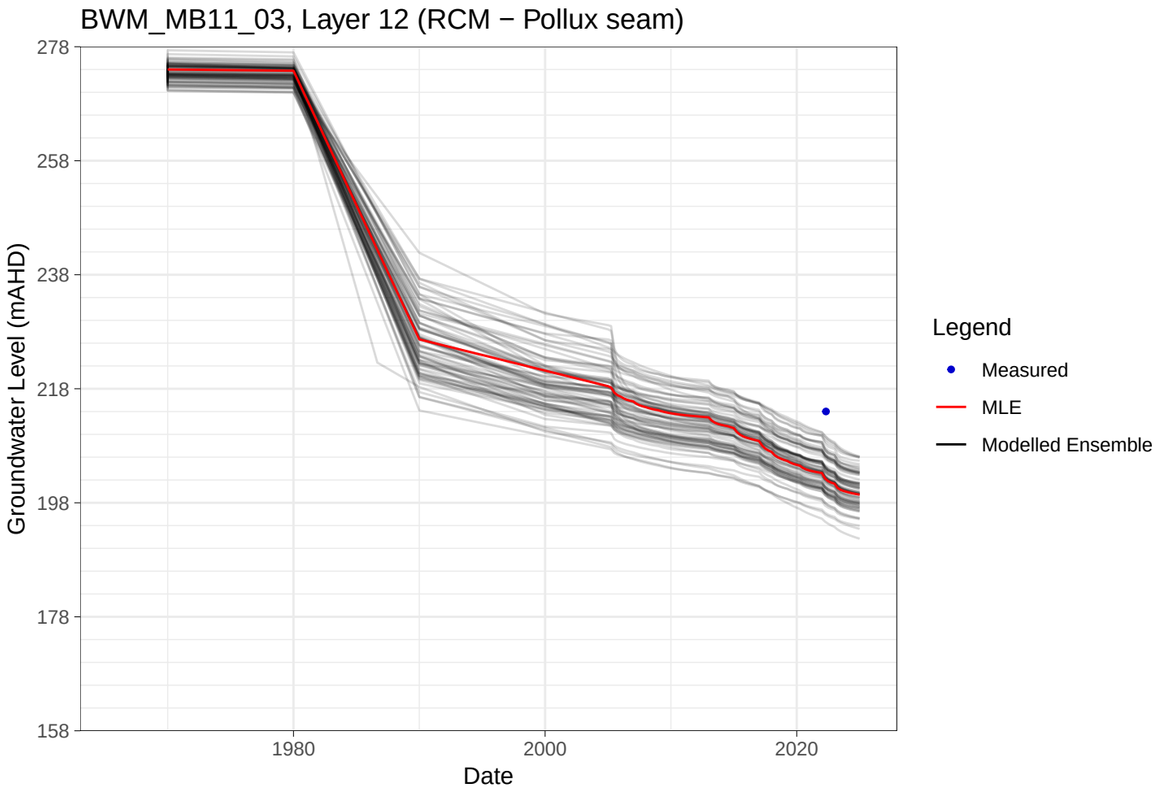

VWP19BWM04−4, Layer 11 (RCM − Interburden)
Groundwater Level (mAHD)
232
228
224
220
216
212
208
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

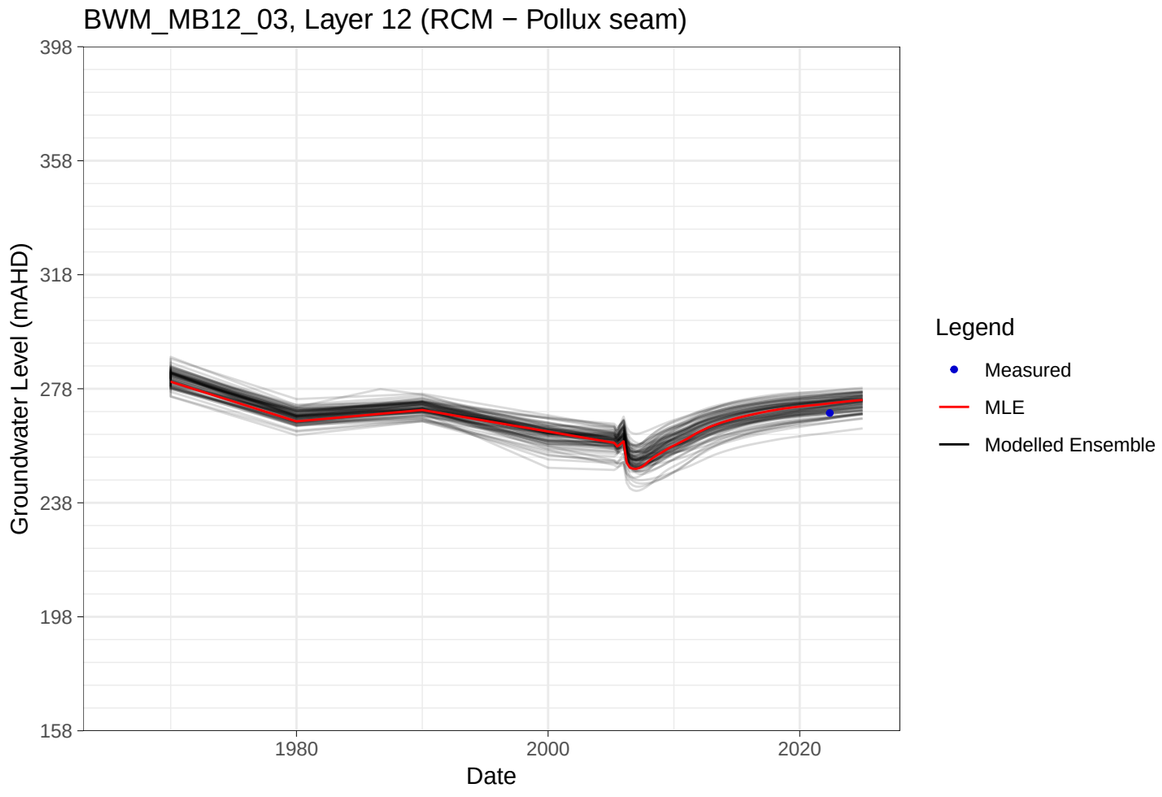

BWM_MB107_04, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
342
322
302
282
262
242
222
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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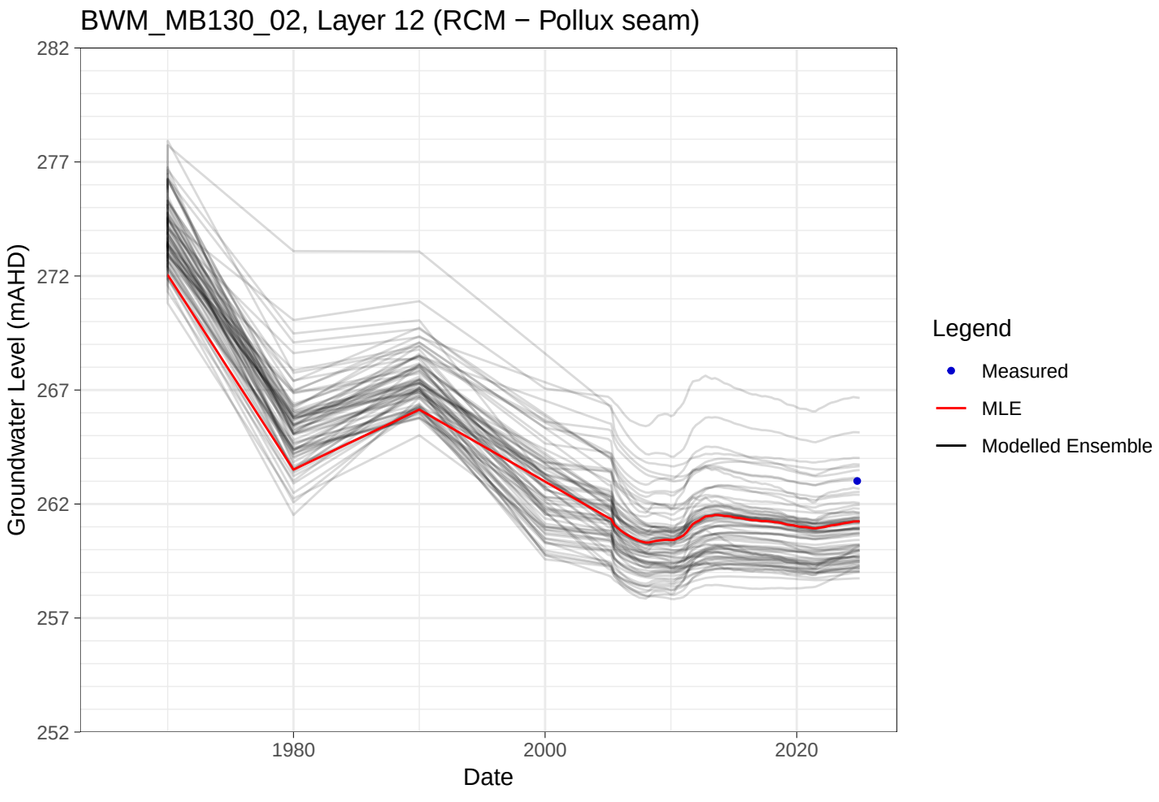

BWM_MB108_04, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
350
330
310
290
270
250
230
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

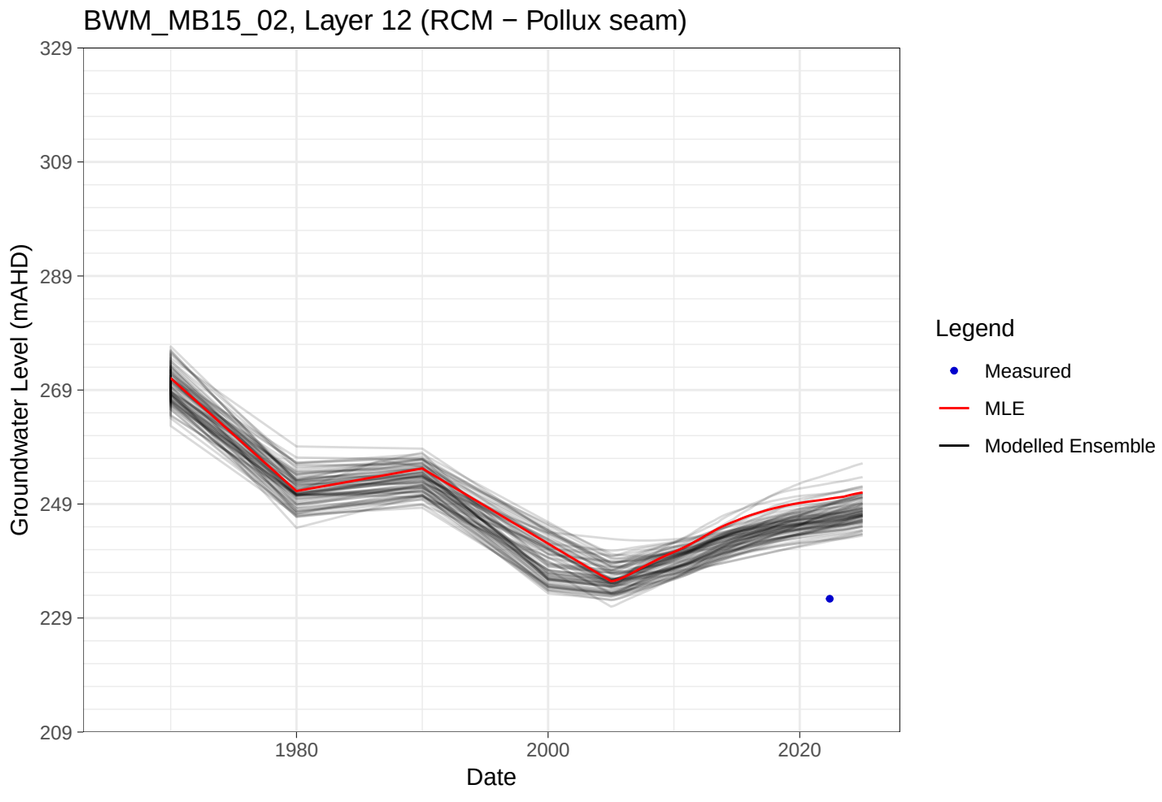

BWM_MB109_02, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
304
294
284
274
264
254
244
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

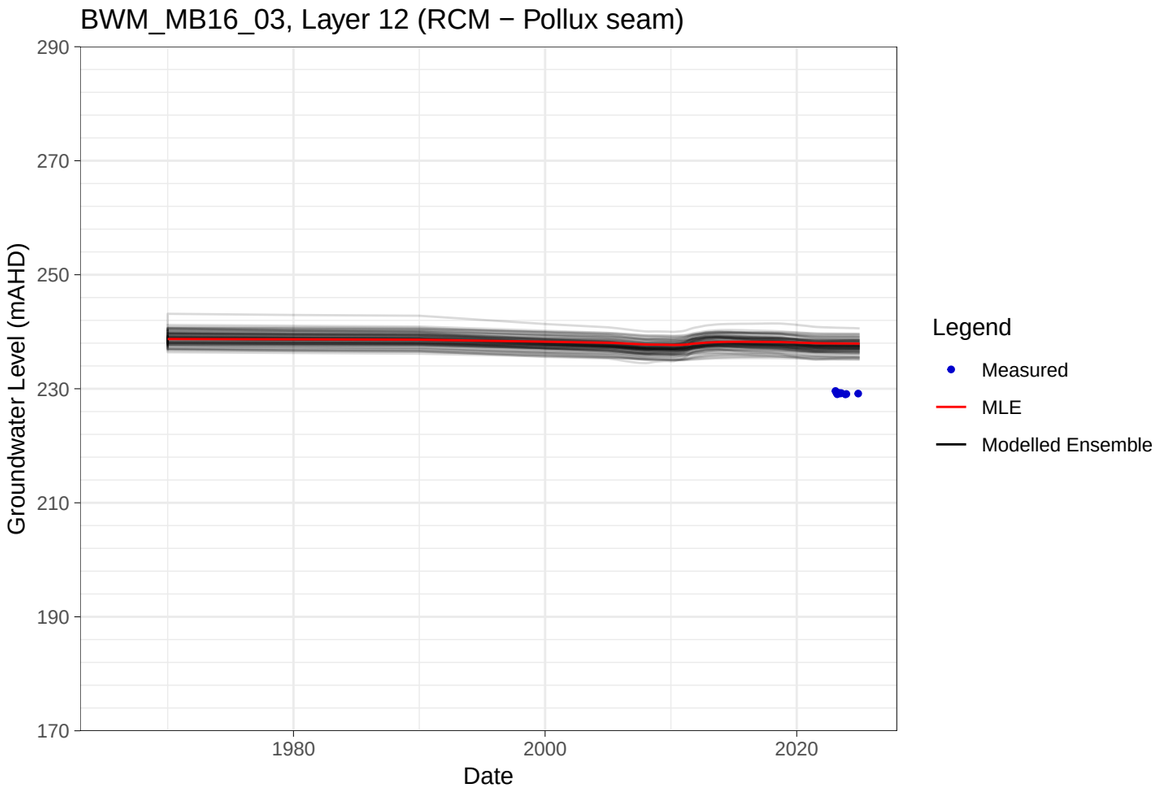

BWM_MB11_03, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
278
258
238
218
198
178
158
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

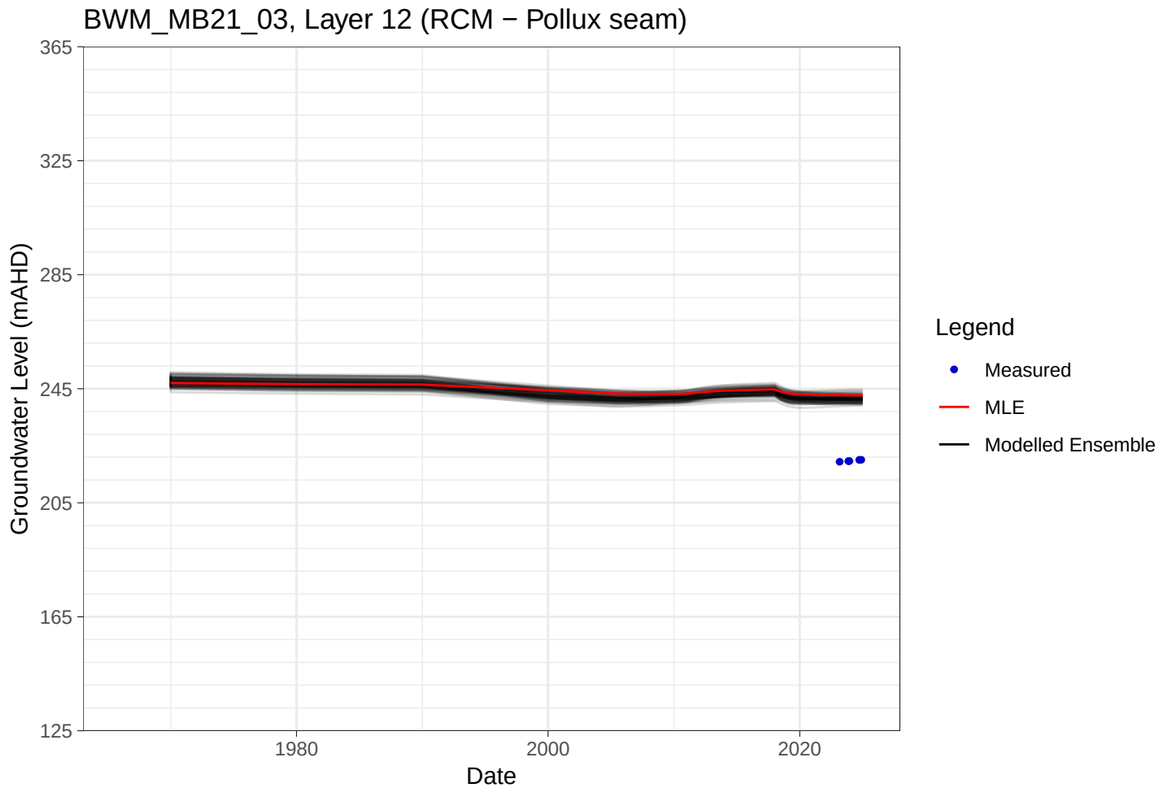

BWM_MB12_03, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
398
358
318
278
238
198
158
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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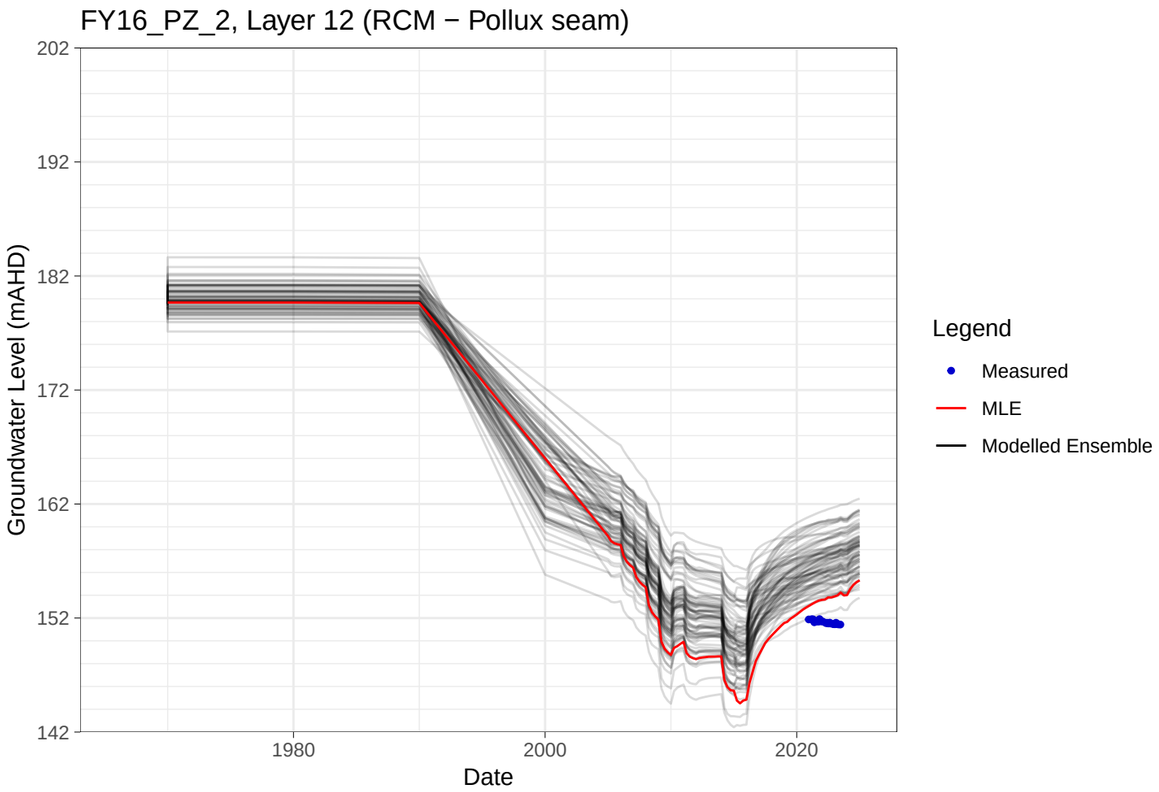

BWM_MB130_02, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
282
277
272
267
262
257
252
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

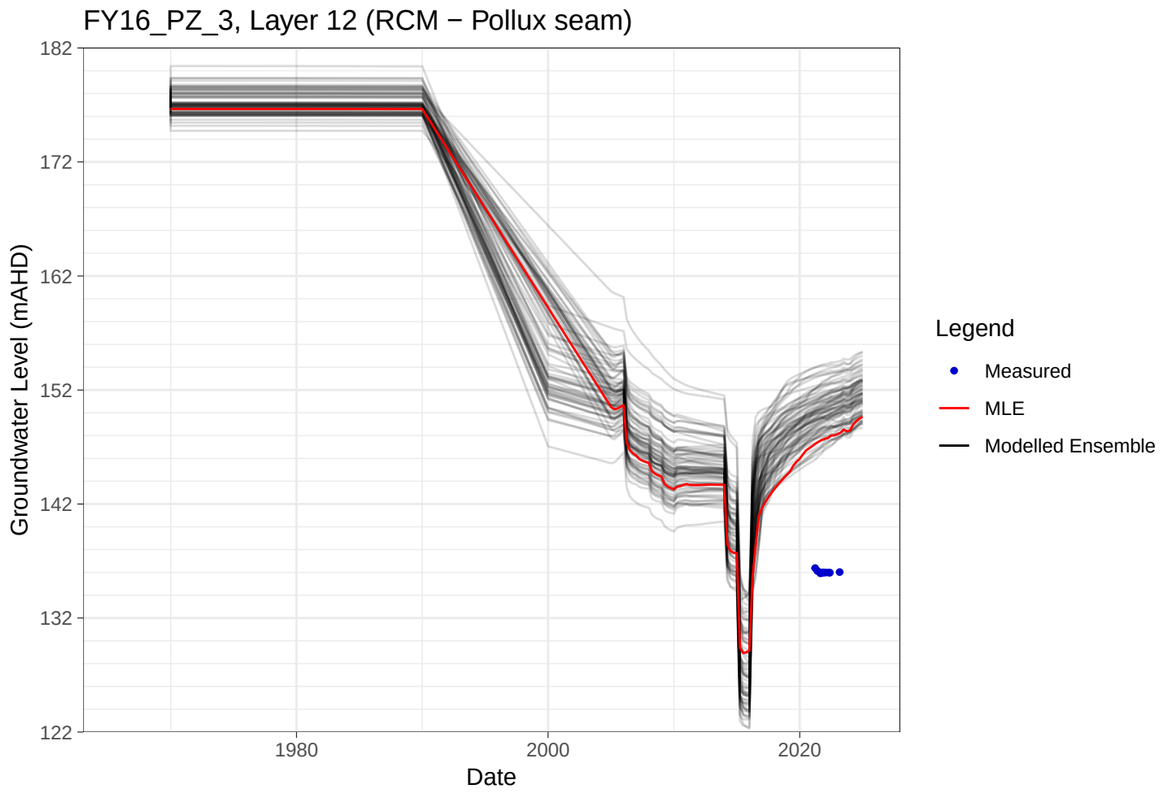

BWM_MB15_02, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
329
309
289
269
249
229
209
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

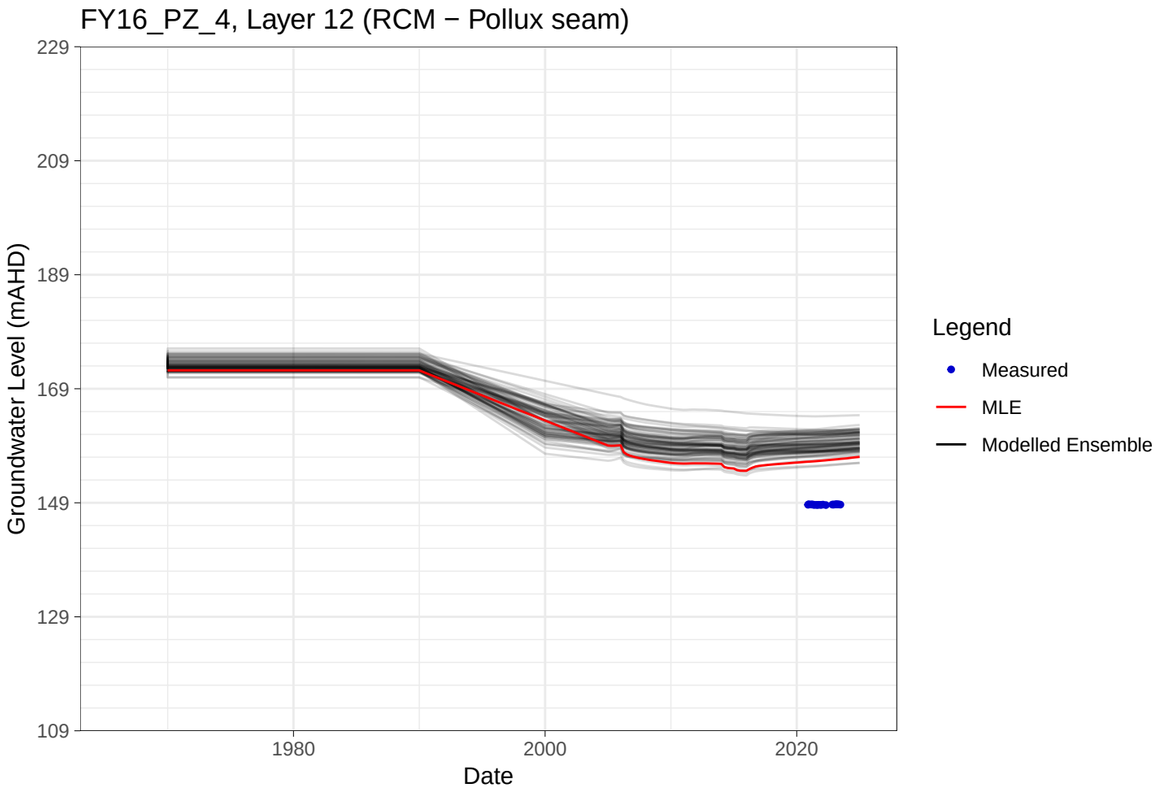

BWM_MB16_03, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
290
270
250
230
210
190
170
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

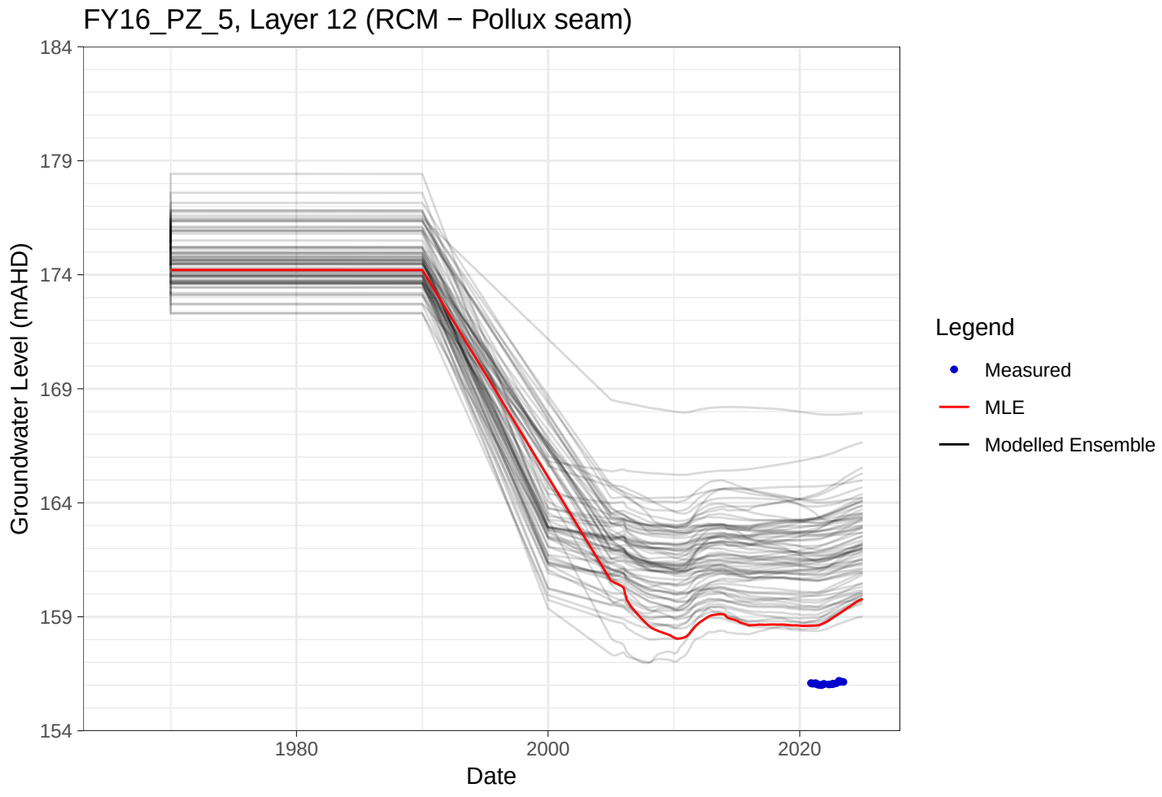

BWM_MB21_03, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
365
325
285
245
205
165
125
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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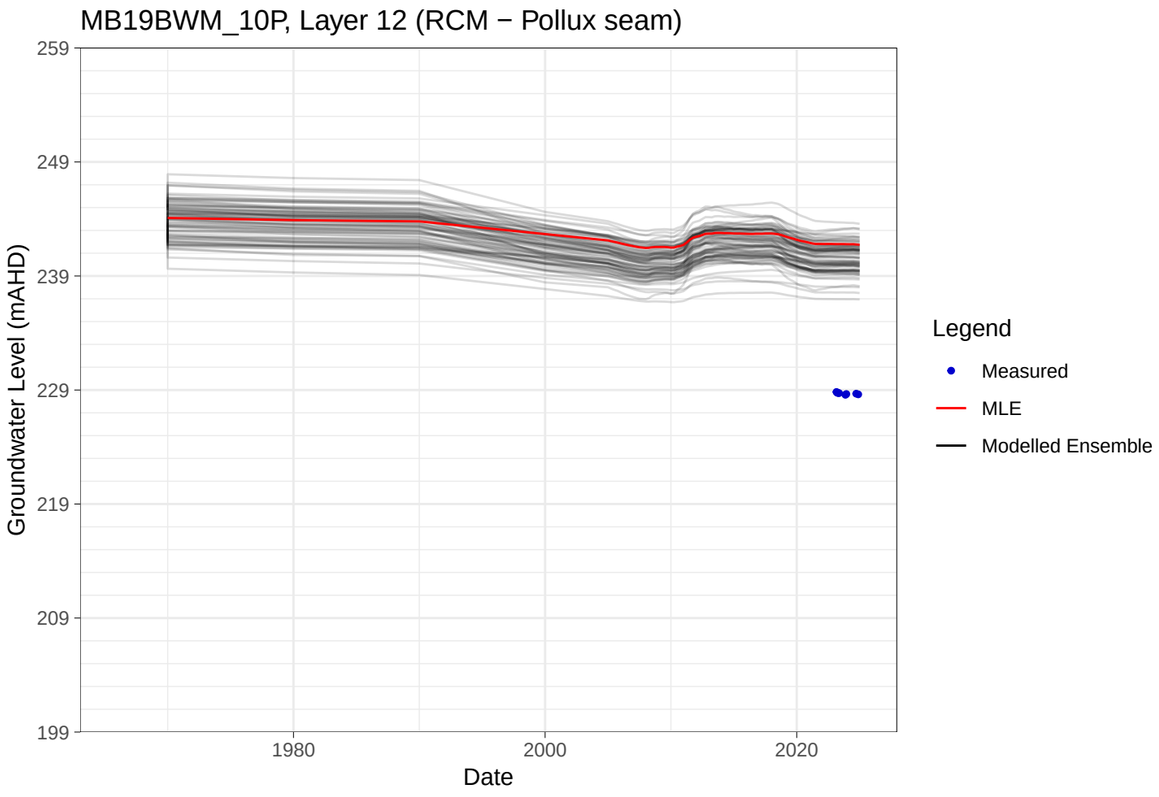

FY16_PZ_2, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
202
192
182
172
162
152
142
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

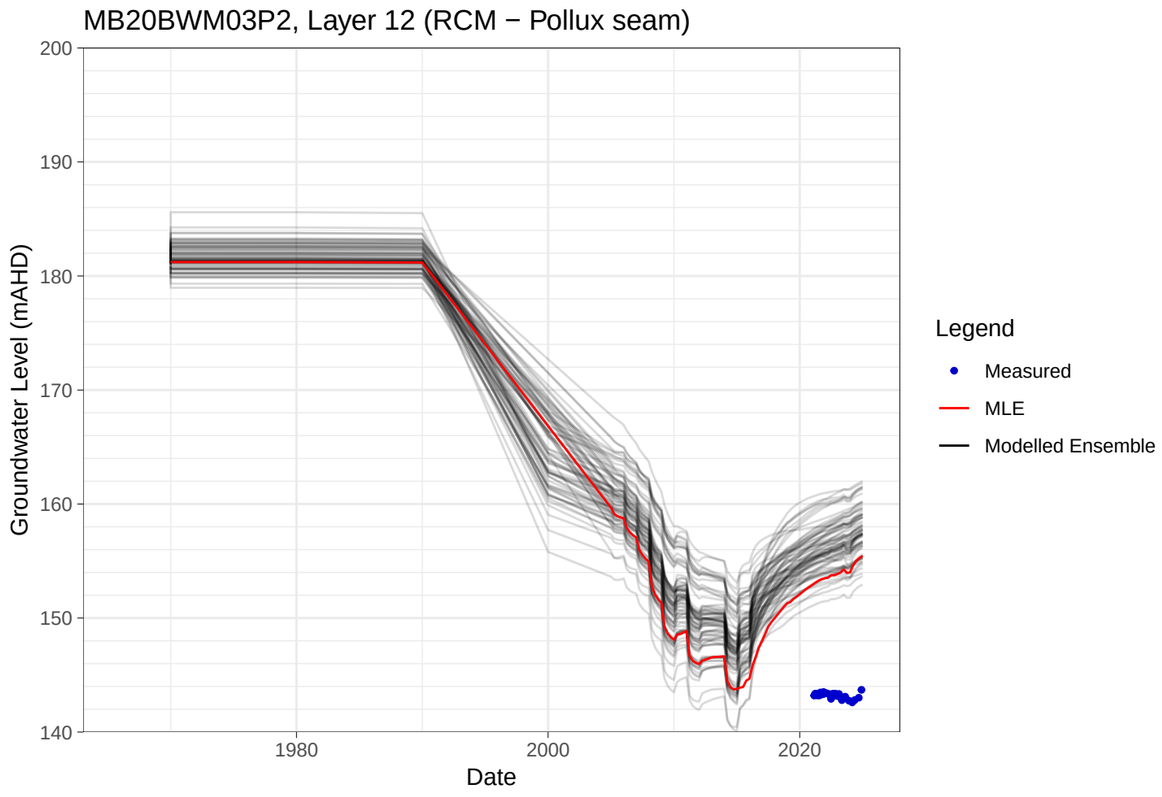

FY16_PZ_3, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
182
172
162
152
142
132
122
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

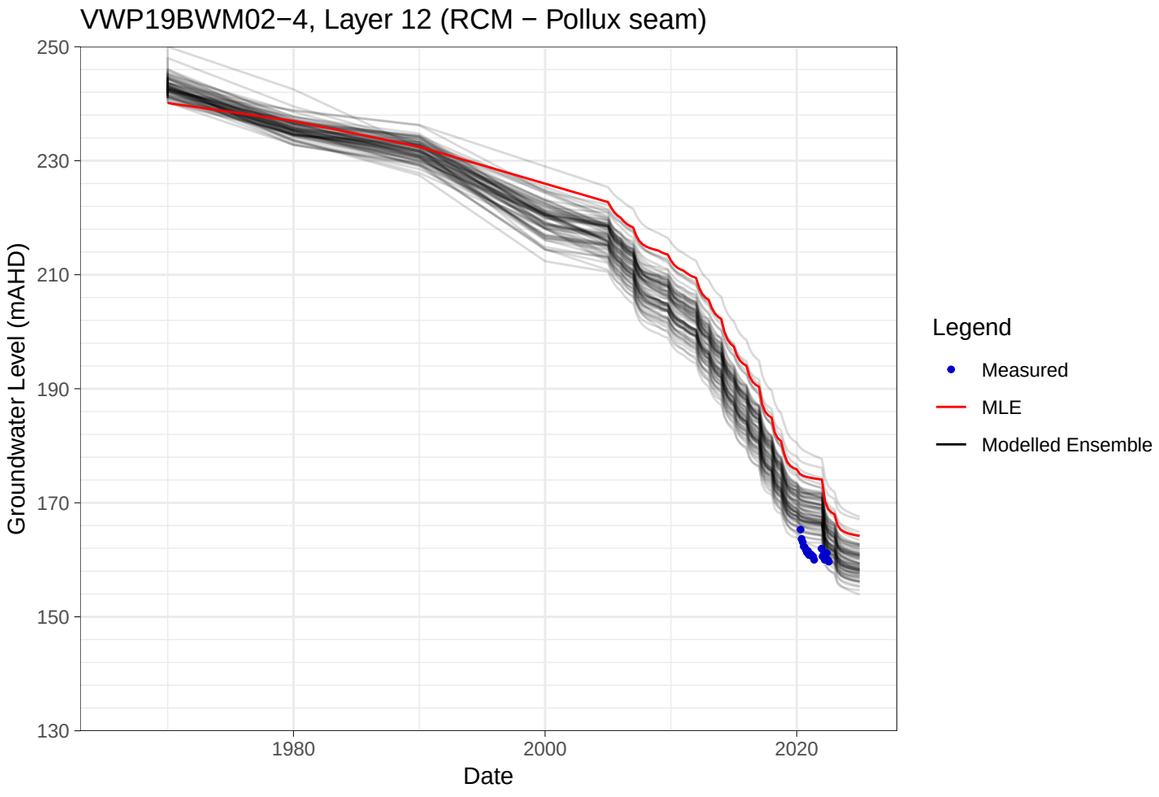

FY16_PZ_4, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
229
209
189
169
149
129
109
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

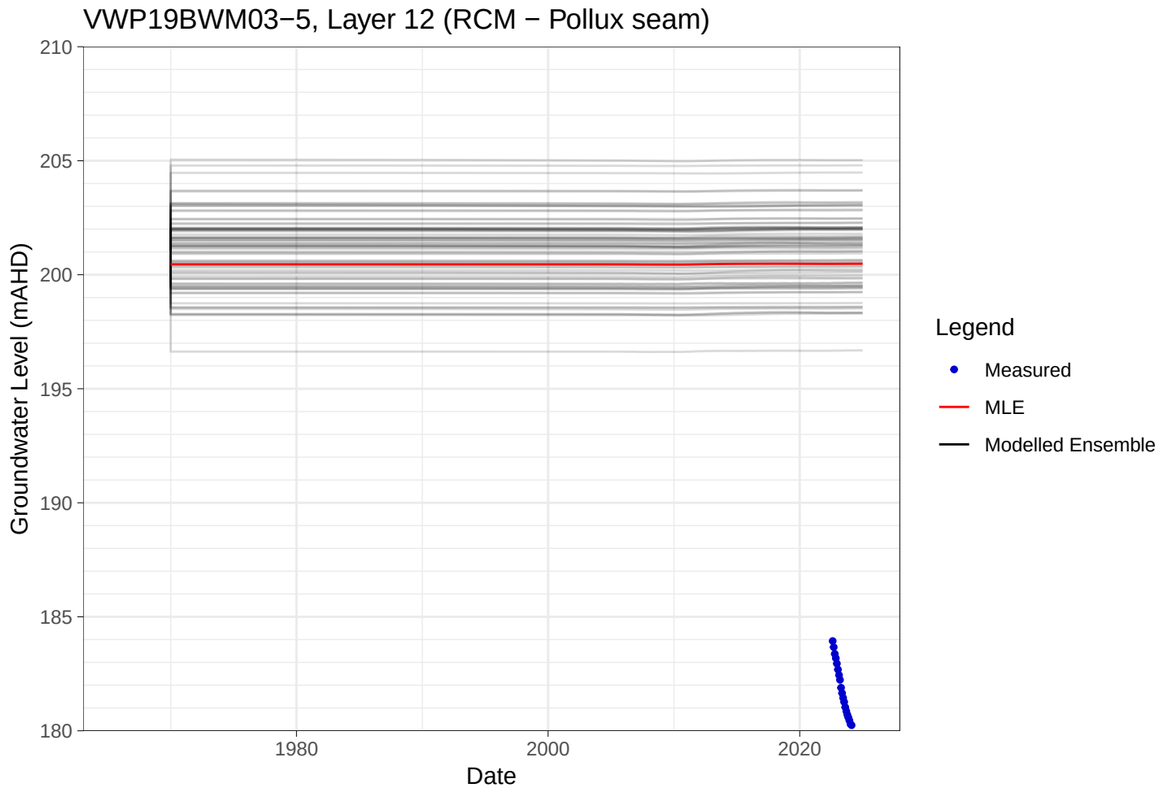

FY16_PZ_5, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
184
179
174
169
164
159
154
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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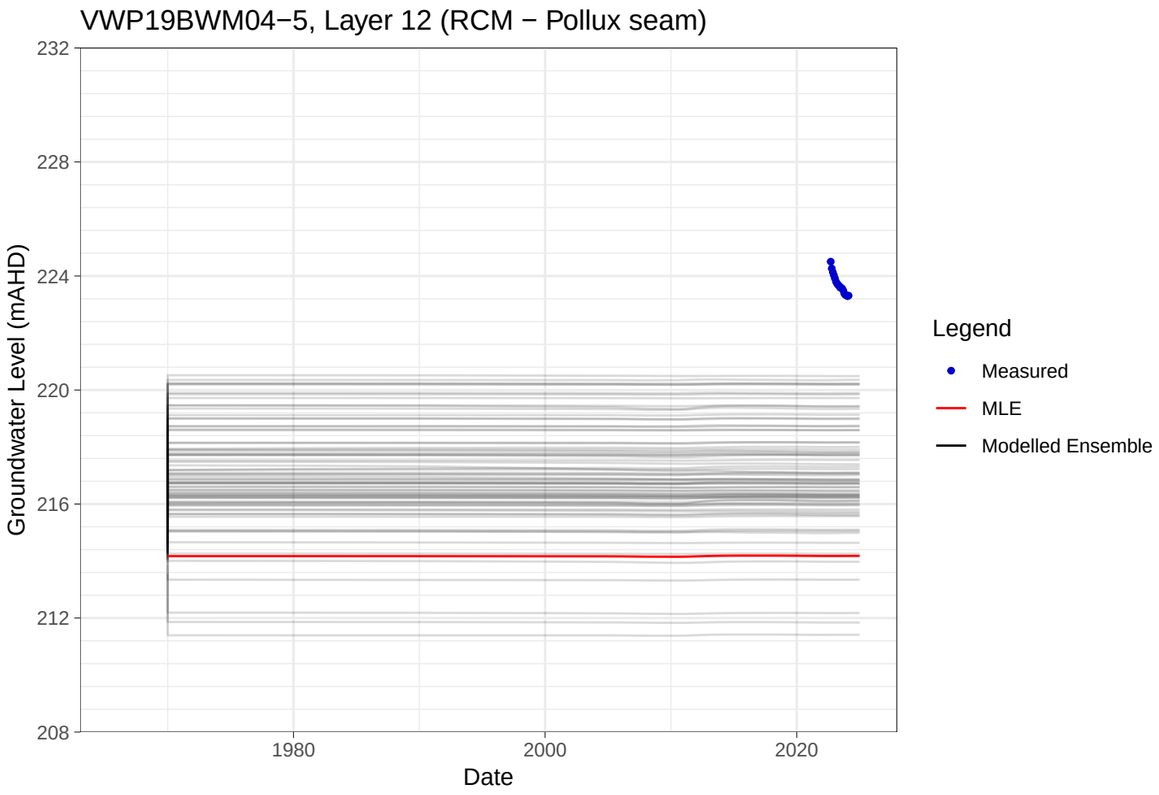

MB19BWM_10P, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
259
249
239
229
219
209
199
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

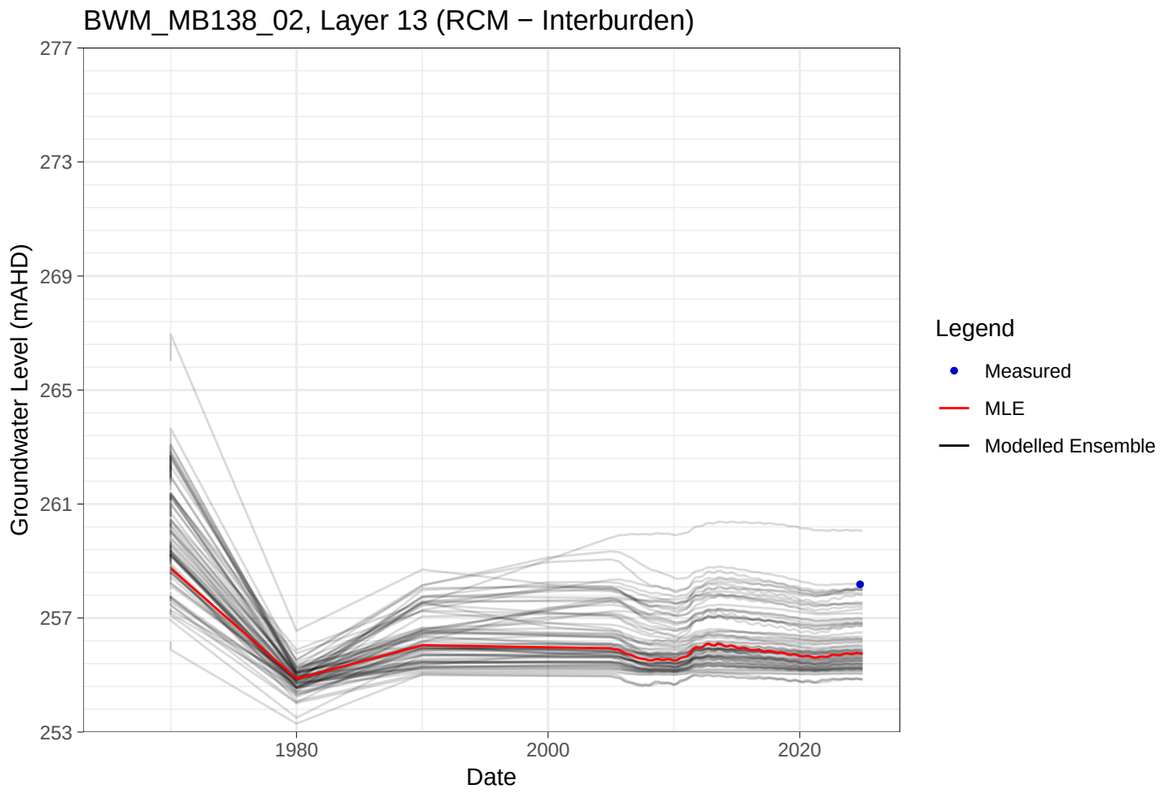

MB20BWM03P2, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
200
190
180
170
160
150
140
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

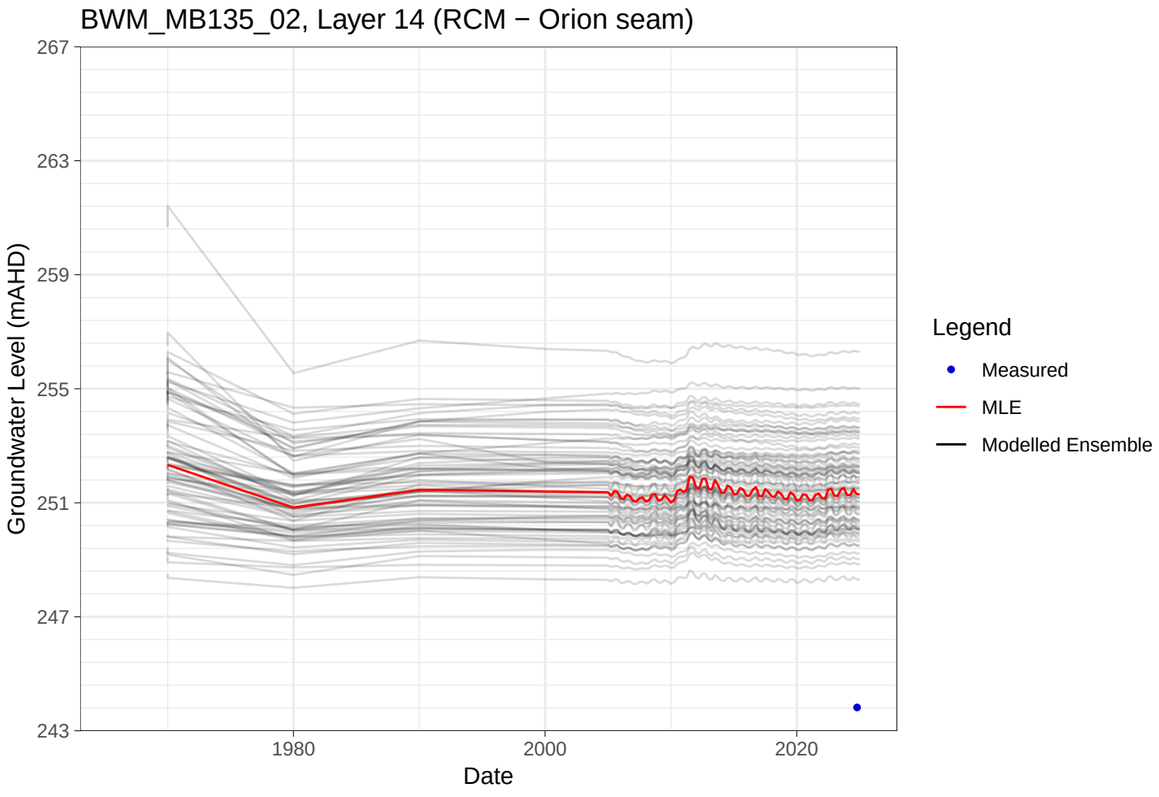

VWP19BWM02−4, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
250
230
210
190
170
150
130
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

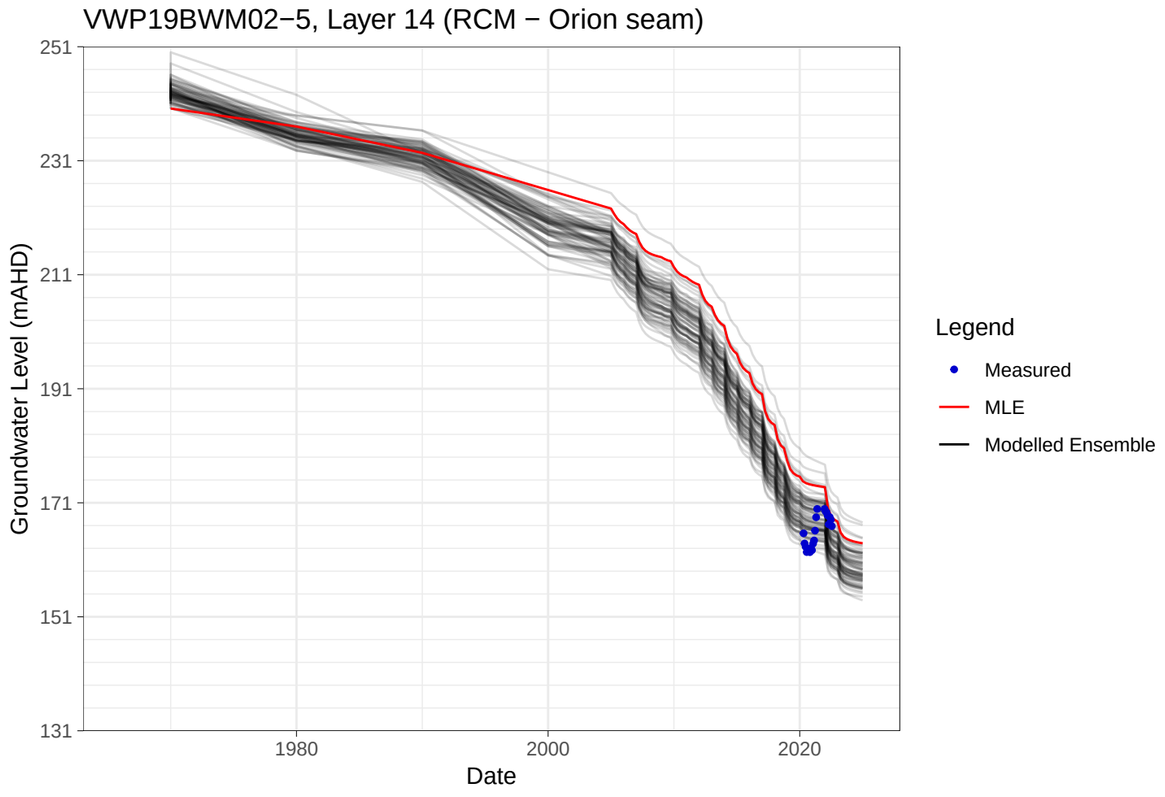

VWP19BWM03−5, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
210
205
200
195
190
185
180
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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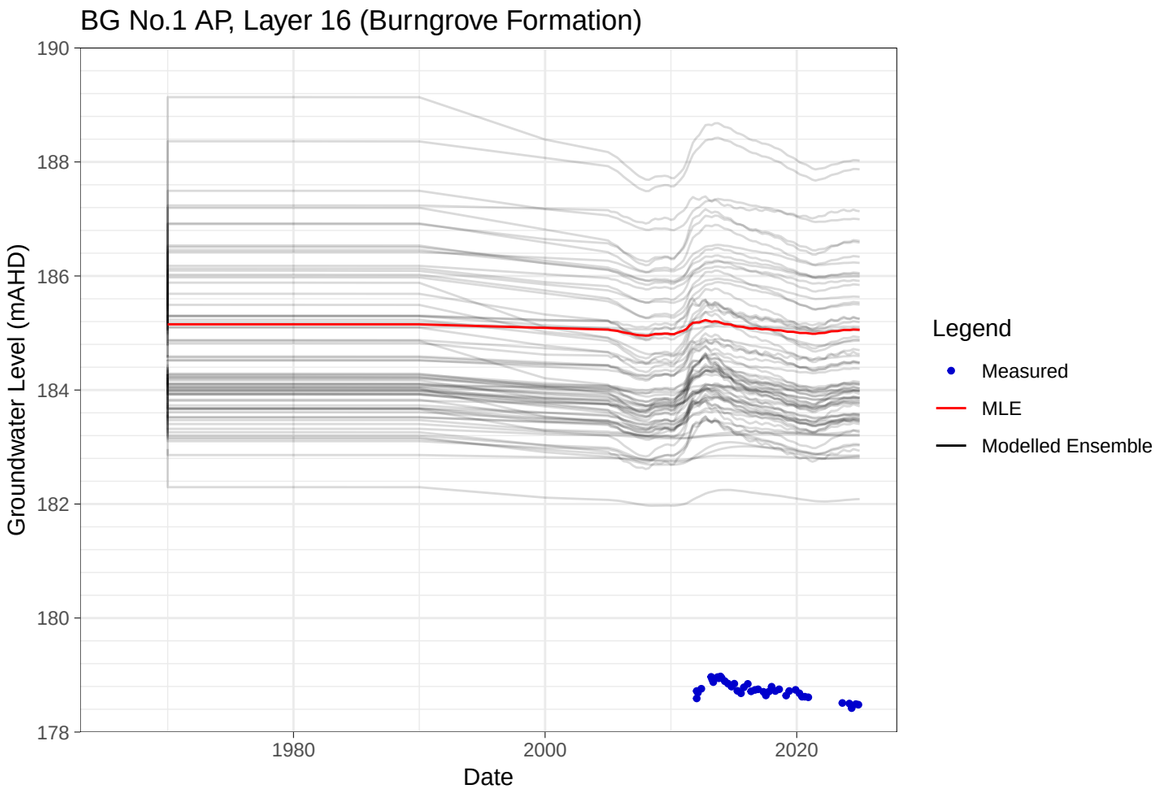

VWP19BWM04−5, Layer 12 (RCM − Pollux seam)
Groundwater Level (mAHD)
232
228
224
220
216
212
208
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

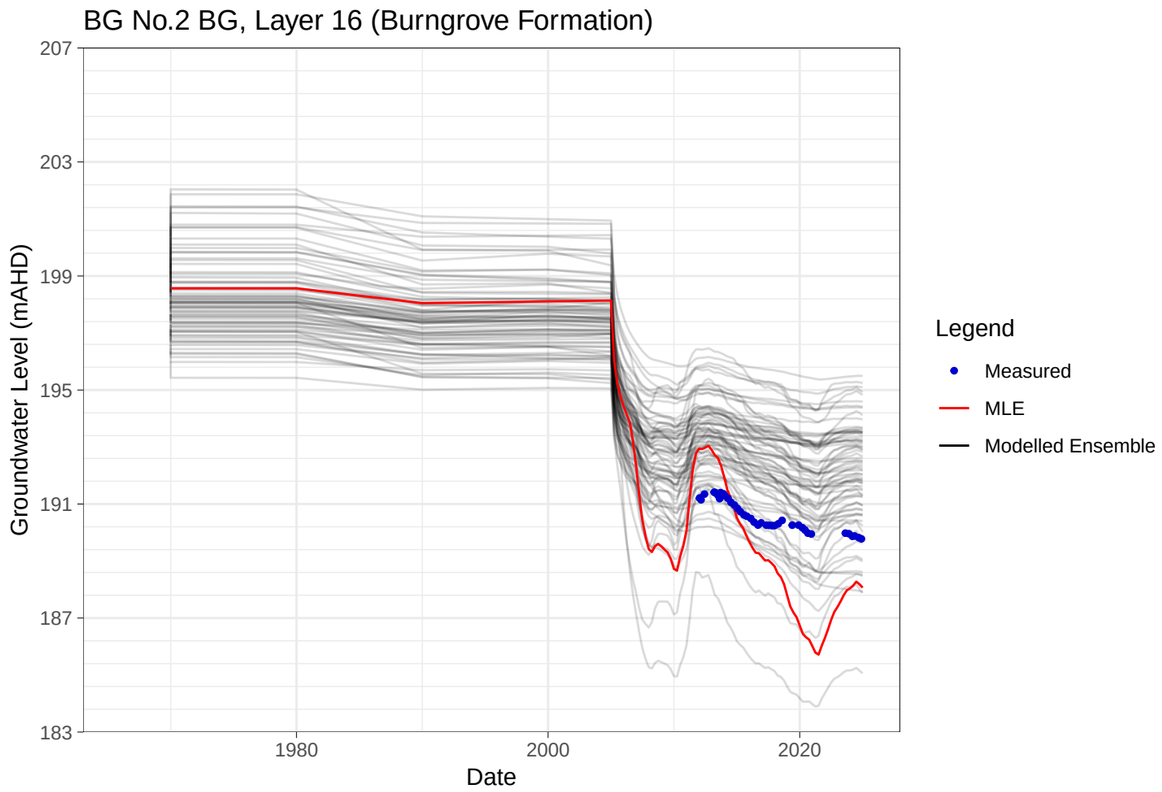

BWM_MB138_02, Layer 13 (RCM − Interburden)
Groundwater Level (mAHD)
277
273
269
265
261
257
253
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

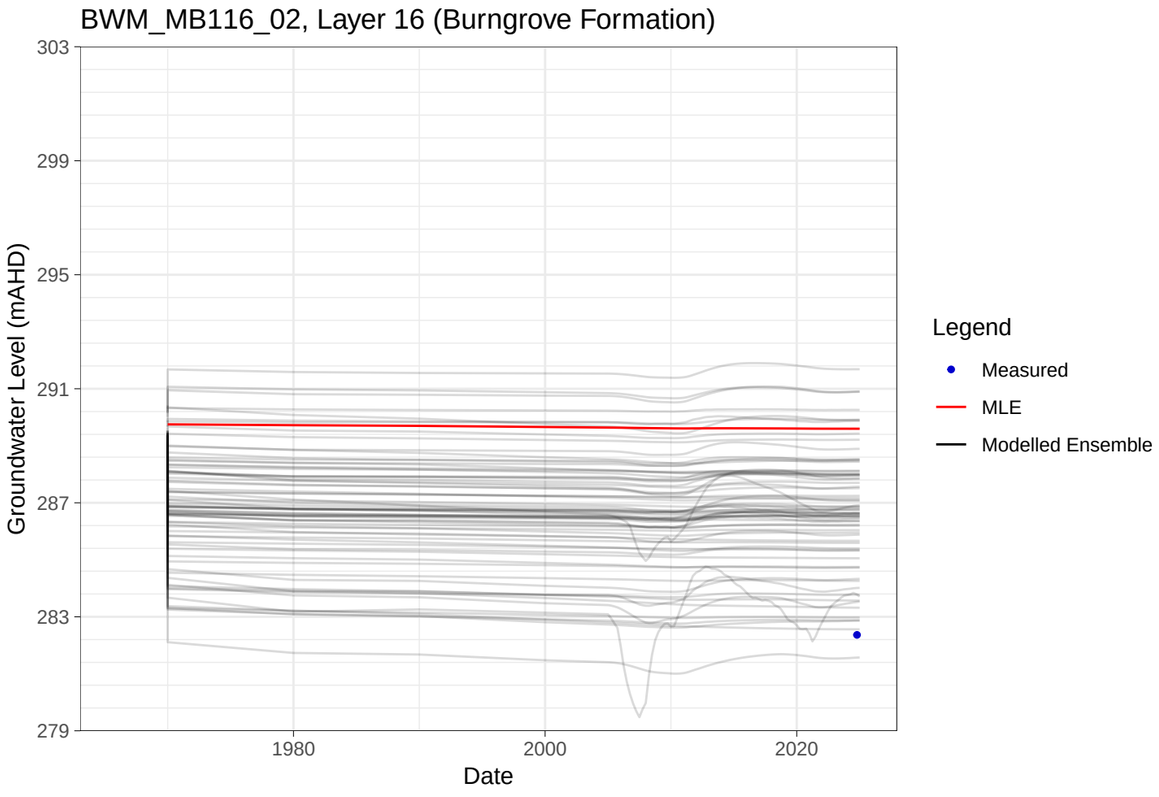

BWM_MB135_02, Layer 14 (RCM − Orion seam)
Groundwater Level (mAHD)
267
263
259
255
251
247
243
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

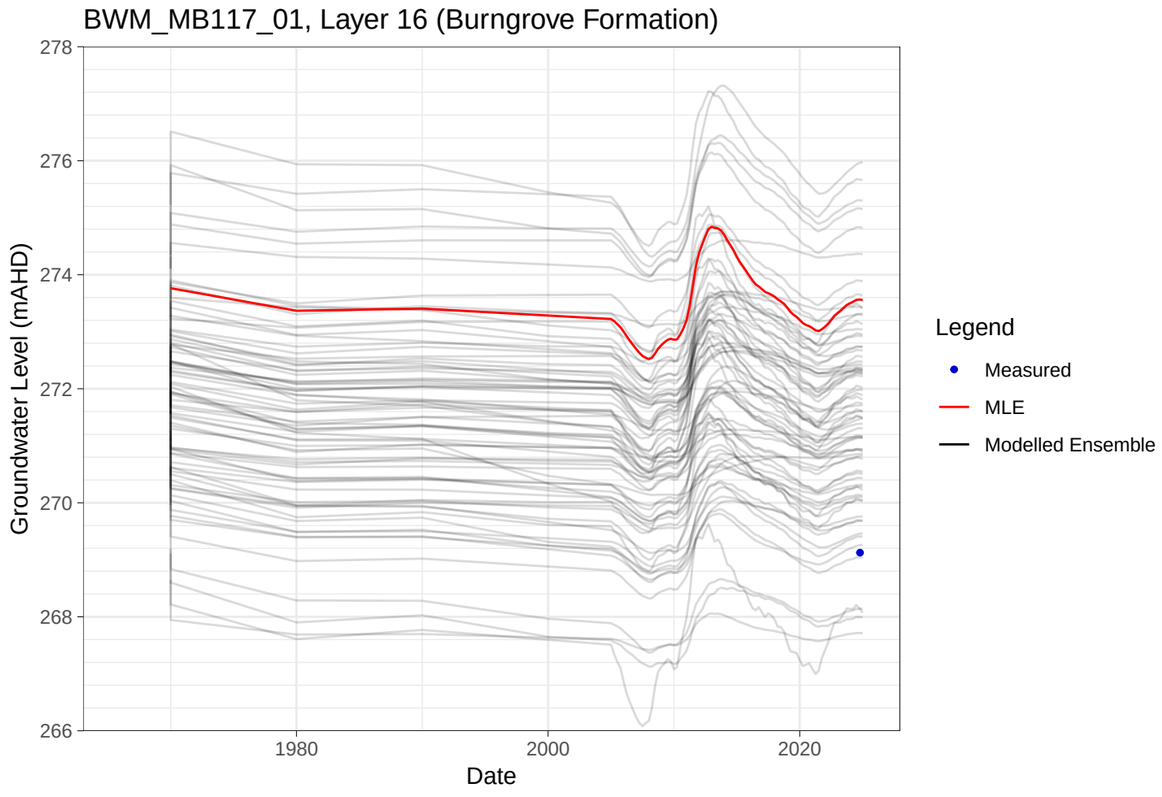

VWP19BWM02−5, Layer 14 (RCM − Orion seam)
Groundwater Level (mAHD)
251
231
211
191
171
151
131
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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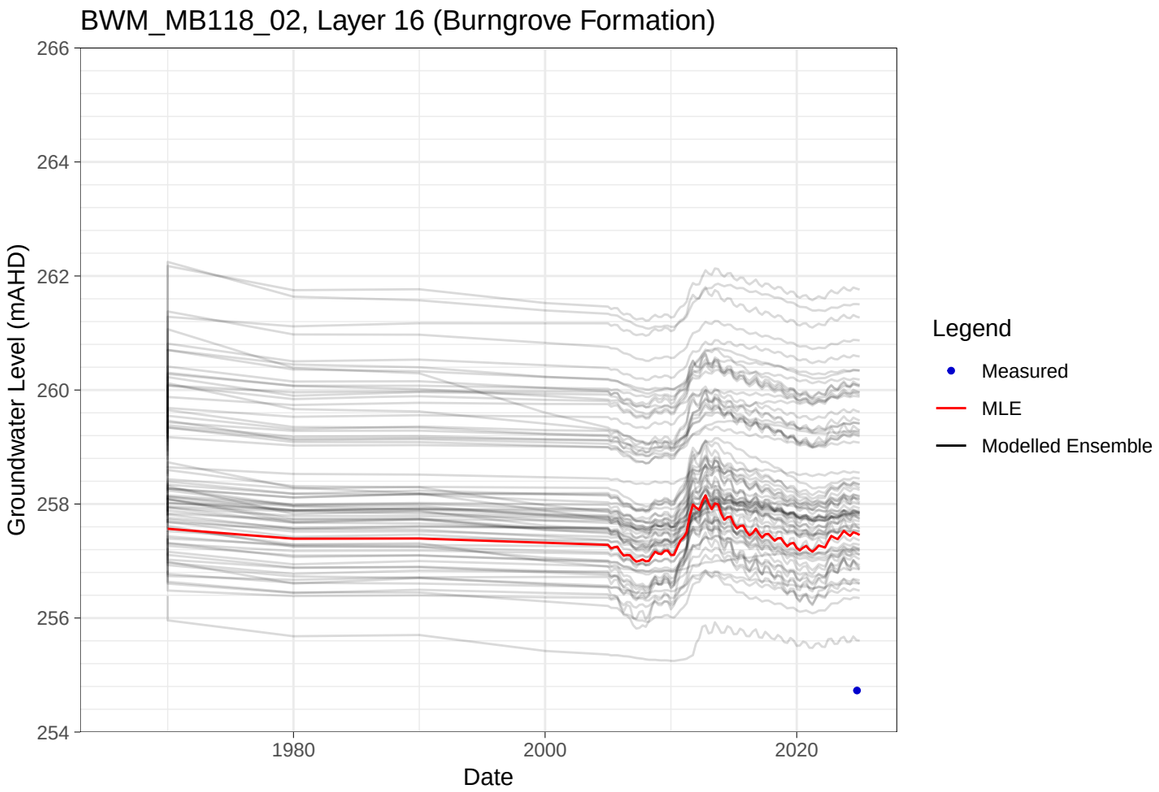

BG No.1 AP, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
190
188
186
184
182
180
178
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

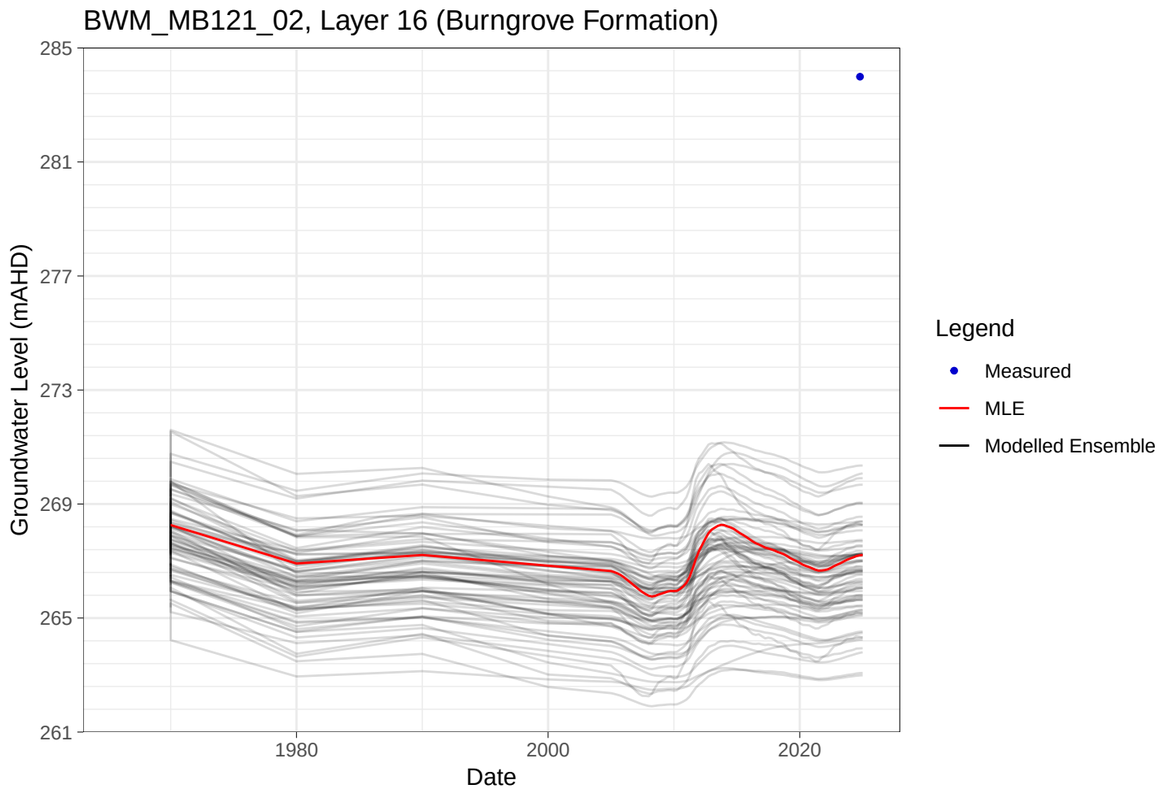

BG No.2 BG, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
207
203
199
195
191
187
183
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

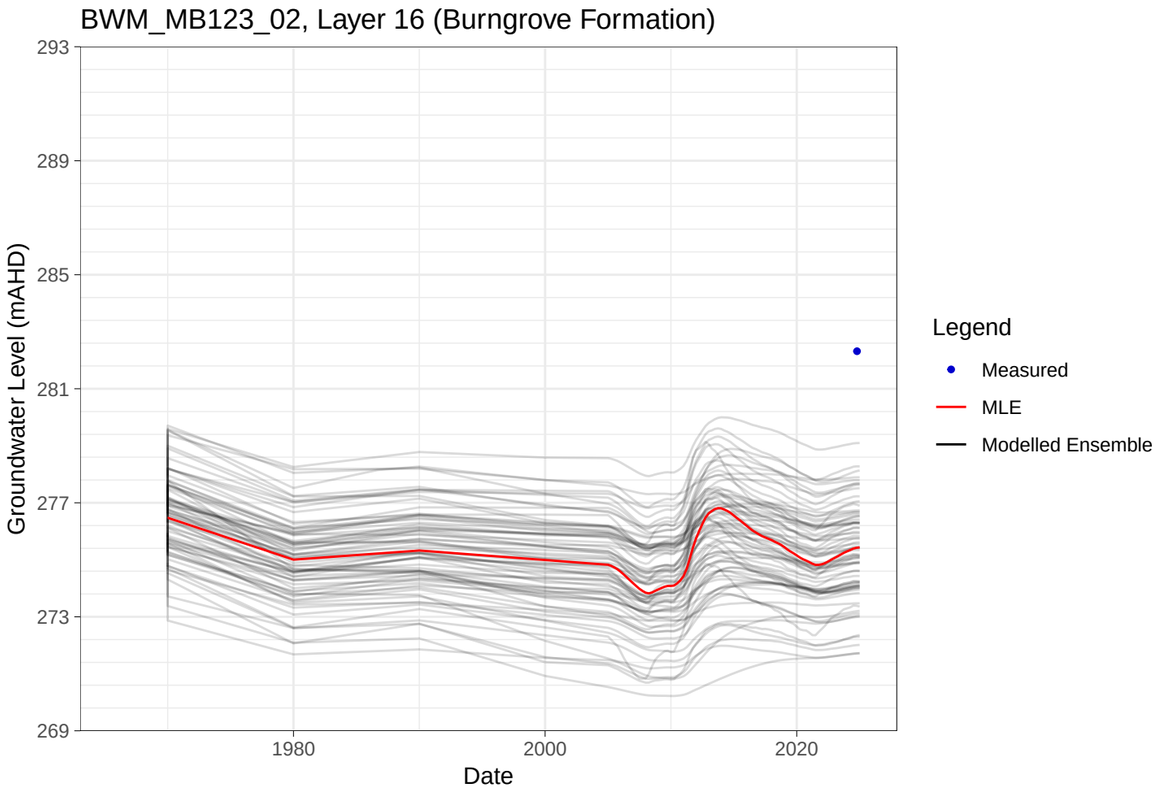

BWM_MB116_02, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
303
299
295
291
287
283
279
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

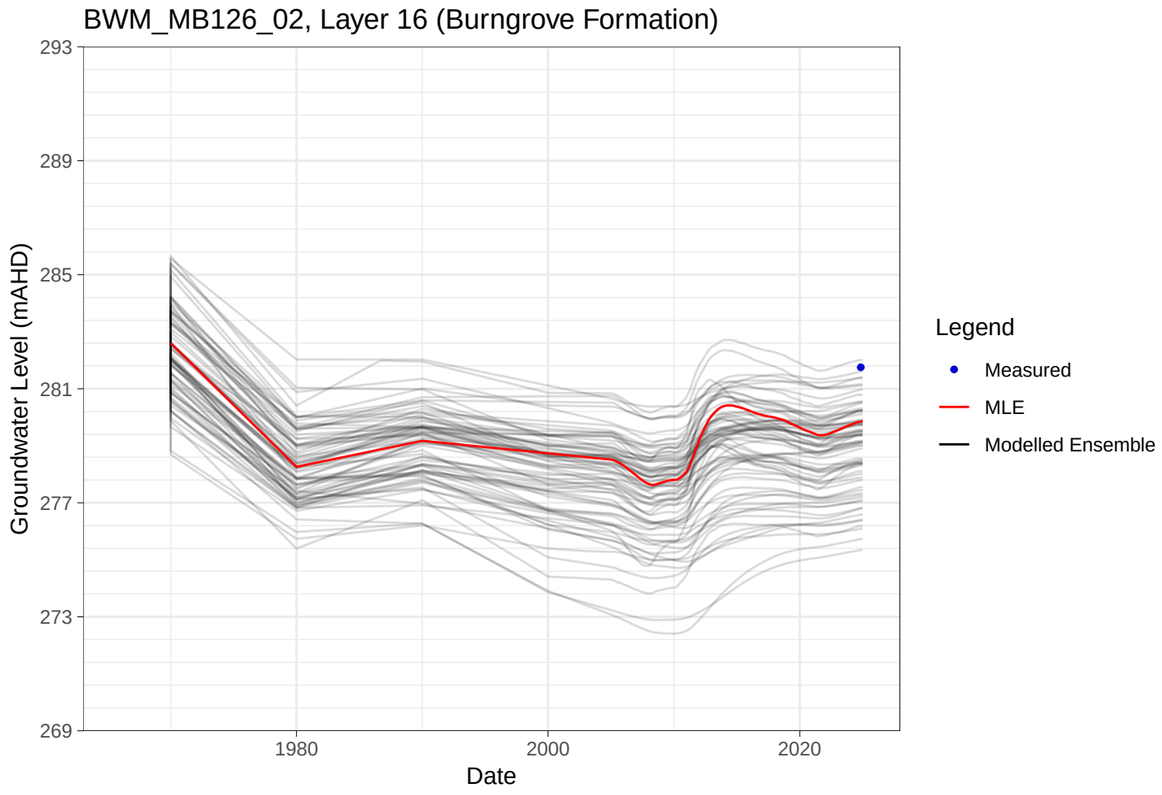

BWM_MB117_01, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
278
276
274
272
270
268
266
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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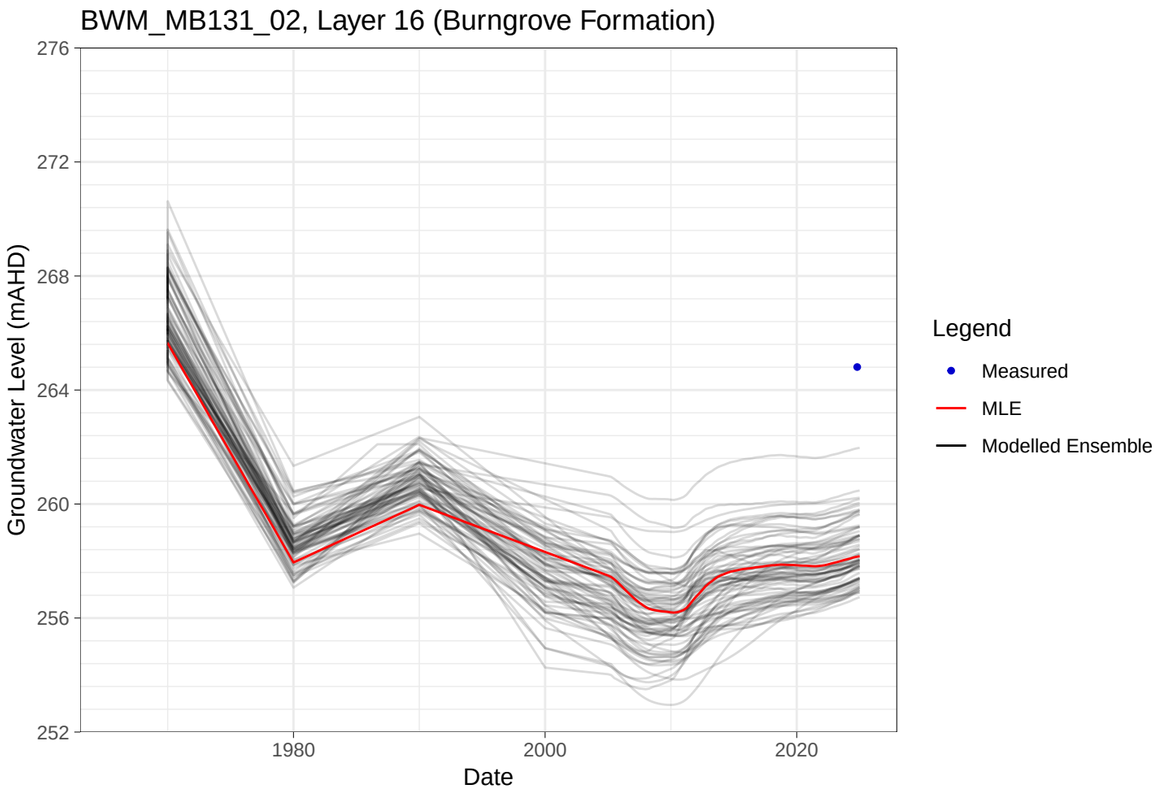

BWM_MB118_02, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
266
264
262
260
258
256
254
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

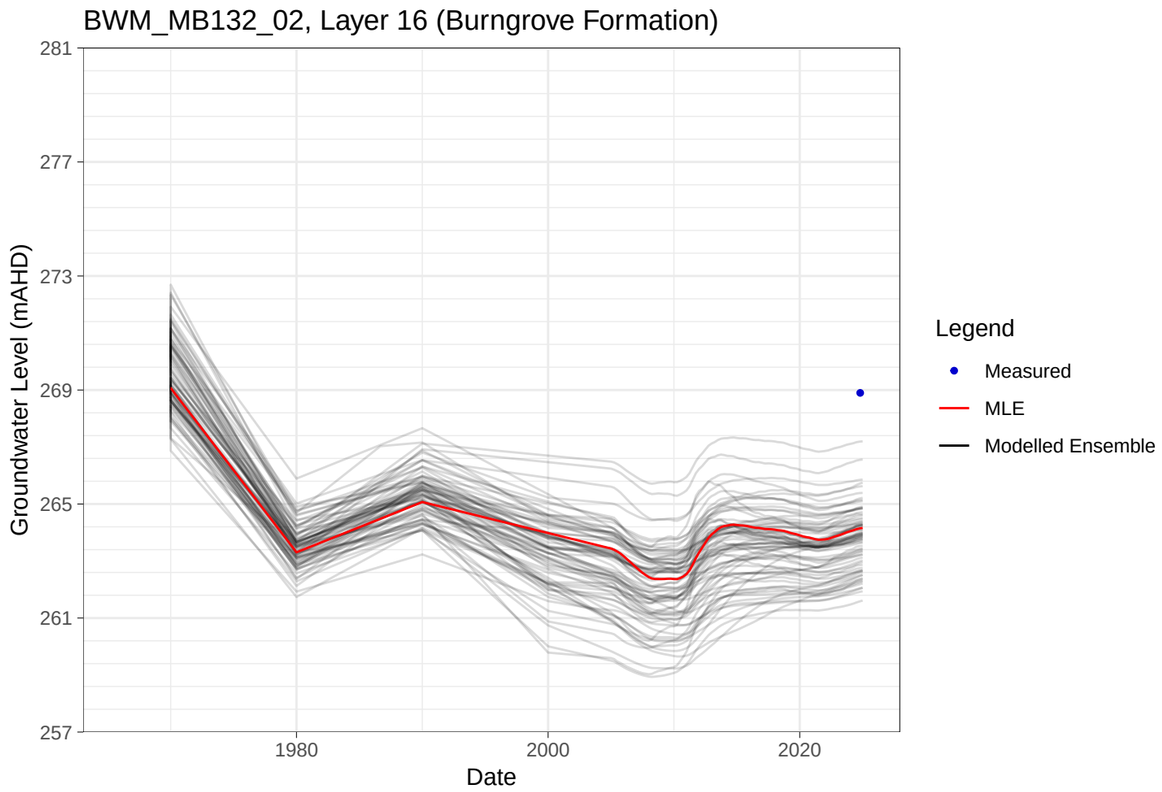

BWM_MB121_02, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
285
281
277
273
269
265
261
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

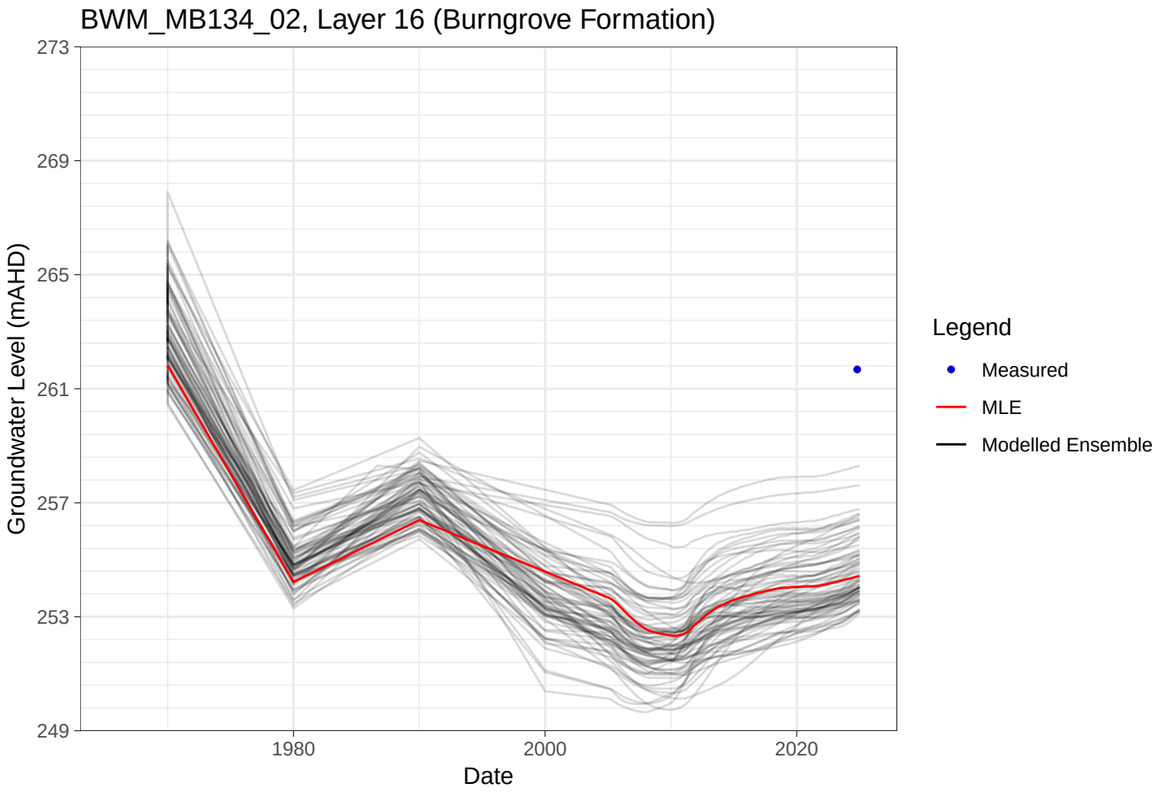

BWM_MB123_02, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
293
289
285
281
277
273
269
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

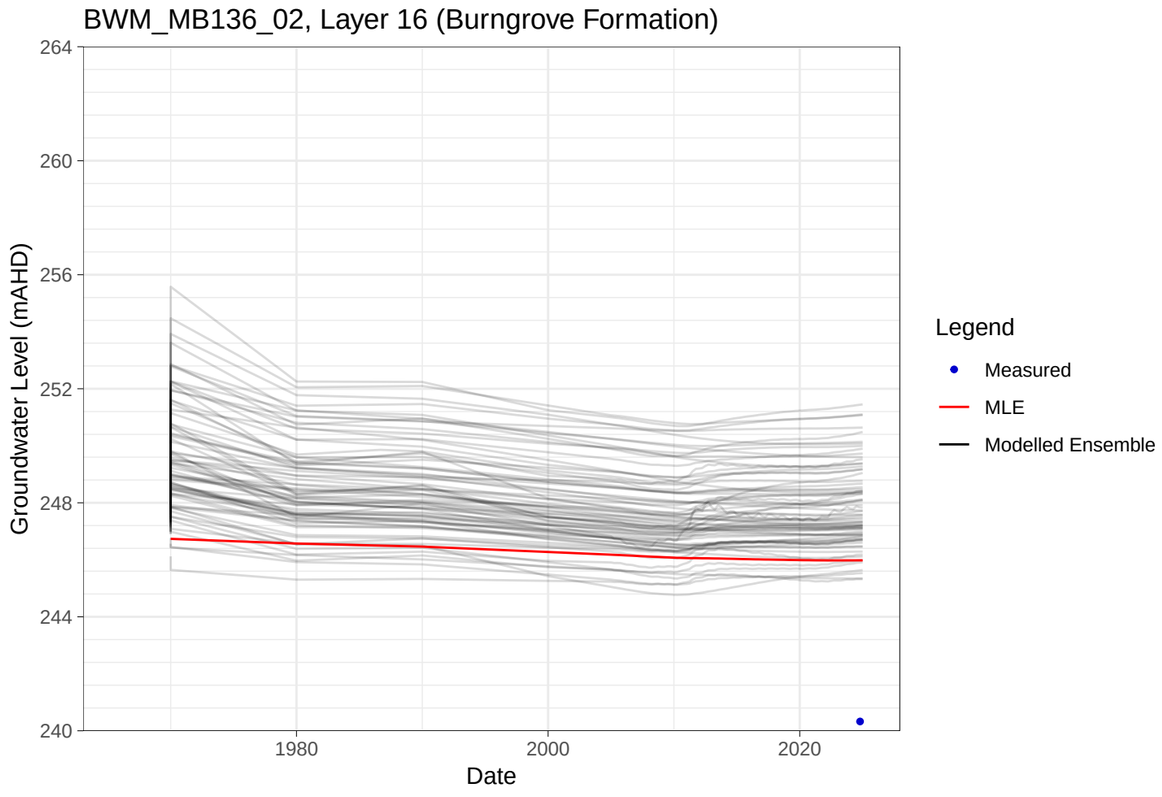

BWM_MB126_02, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
293
289
285
281
277
273
269
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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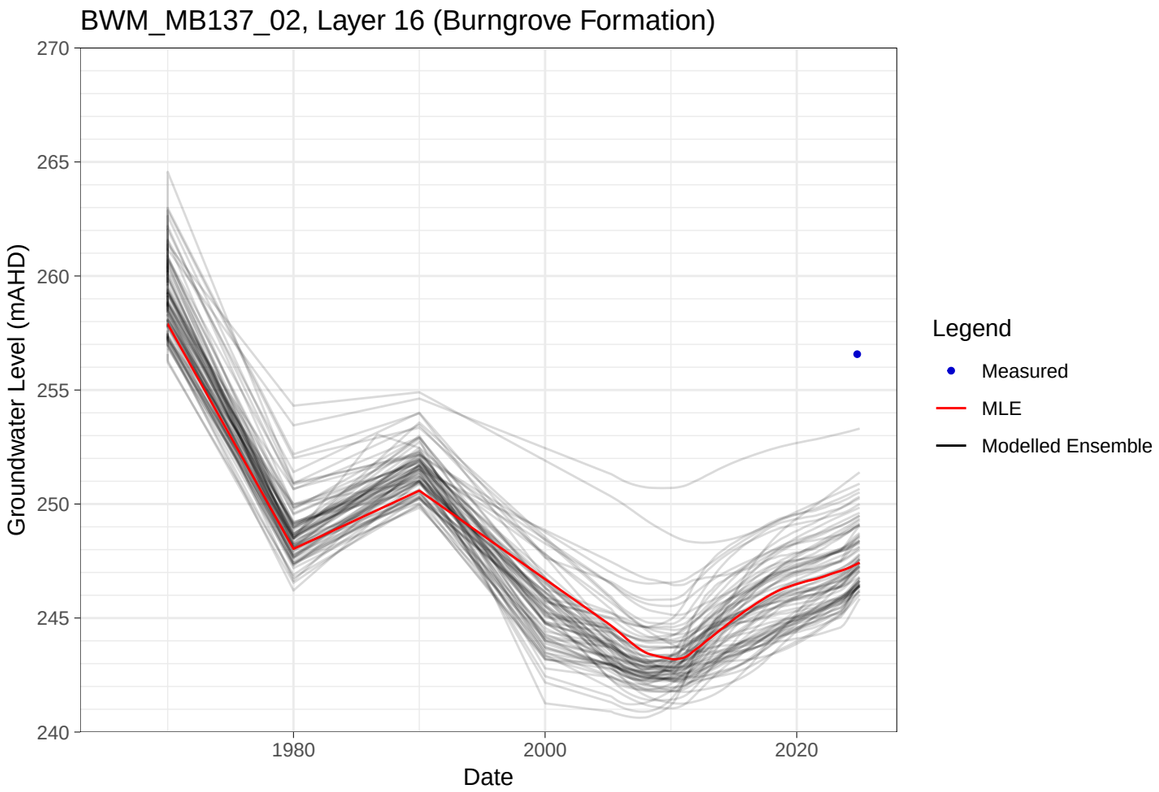

BWM_MB131_02, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
276
272
268
264
260
256
252
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

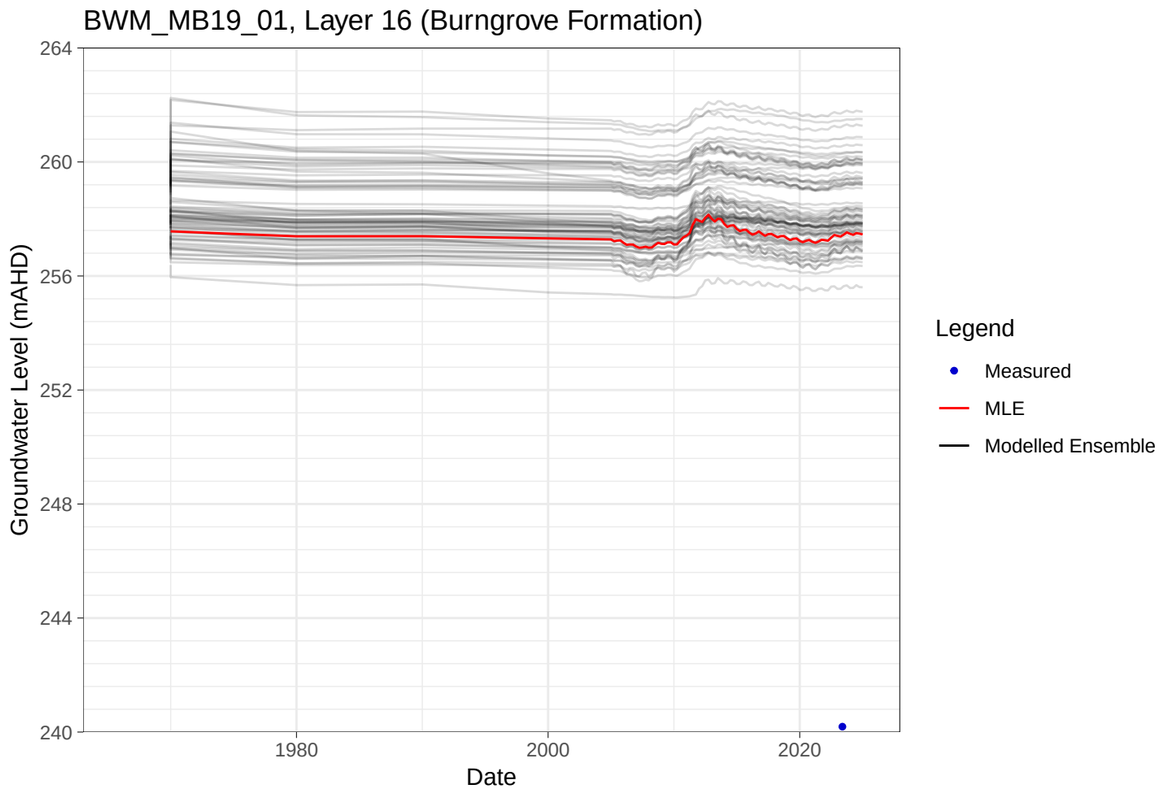

BWM_MB132_02, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
281
277
273
269
265
261
257
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

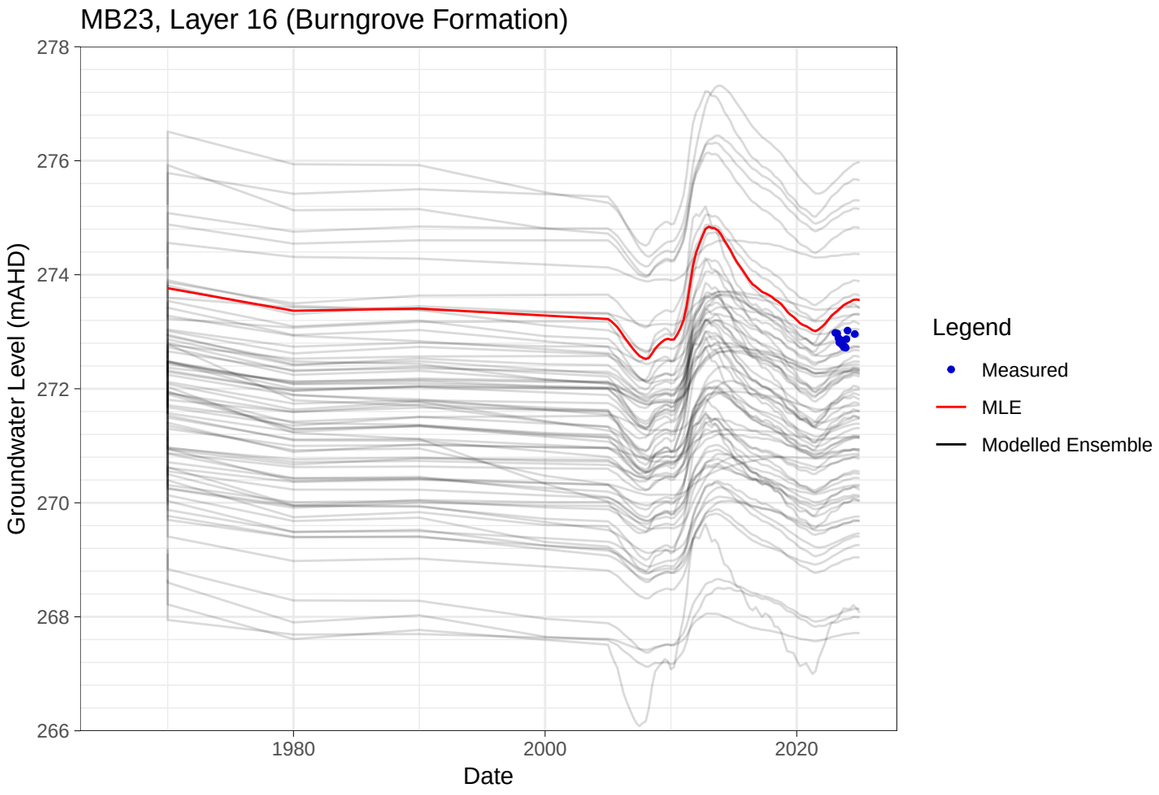

BWM_MB134_02, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
273
269
265
261
257
253
249
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

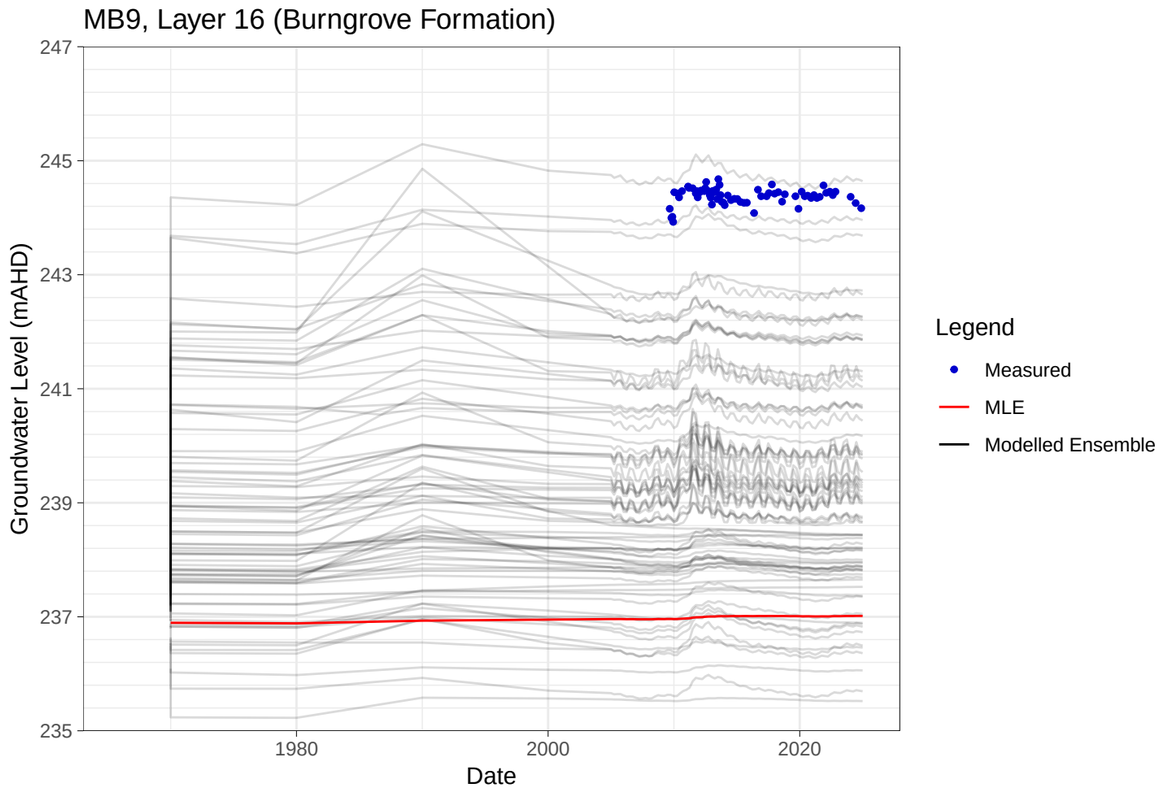

BWM_MB136_02, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
264
260
256
252
248
244
240
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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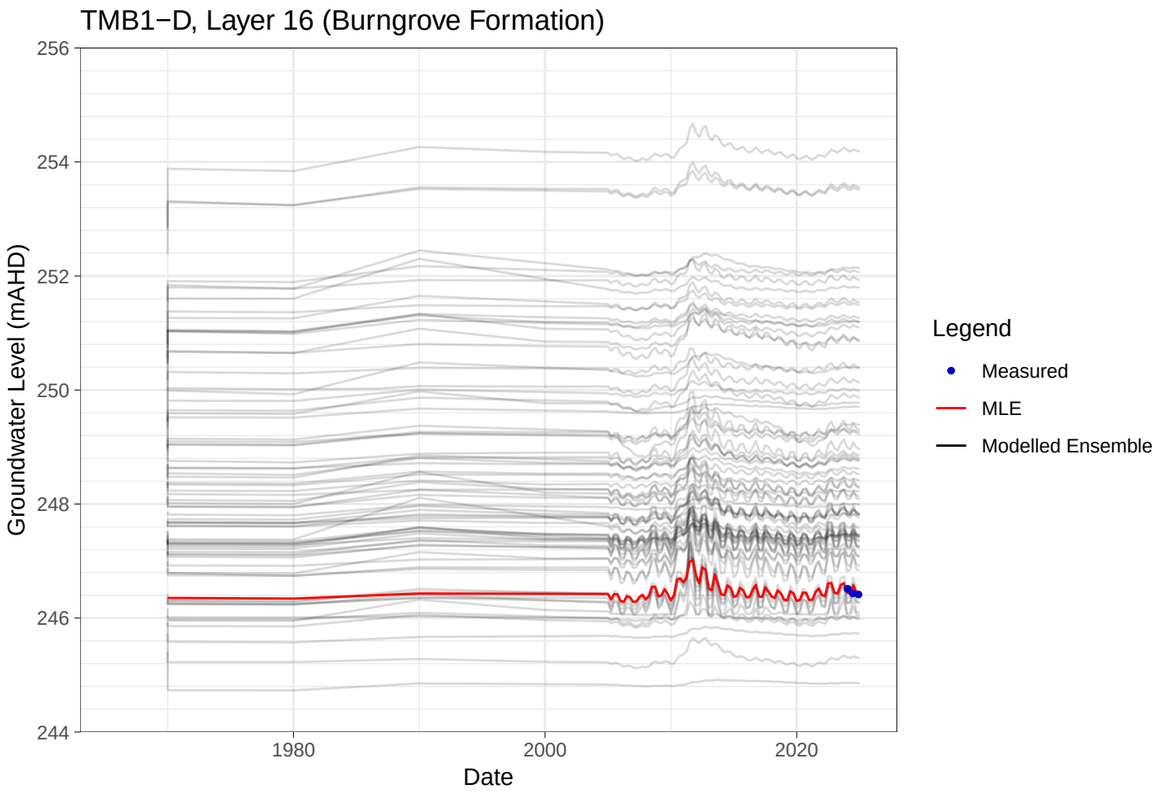

BWM_MB137_02, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
270
265
260
255
250
245
240
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

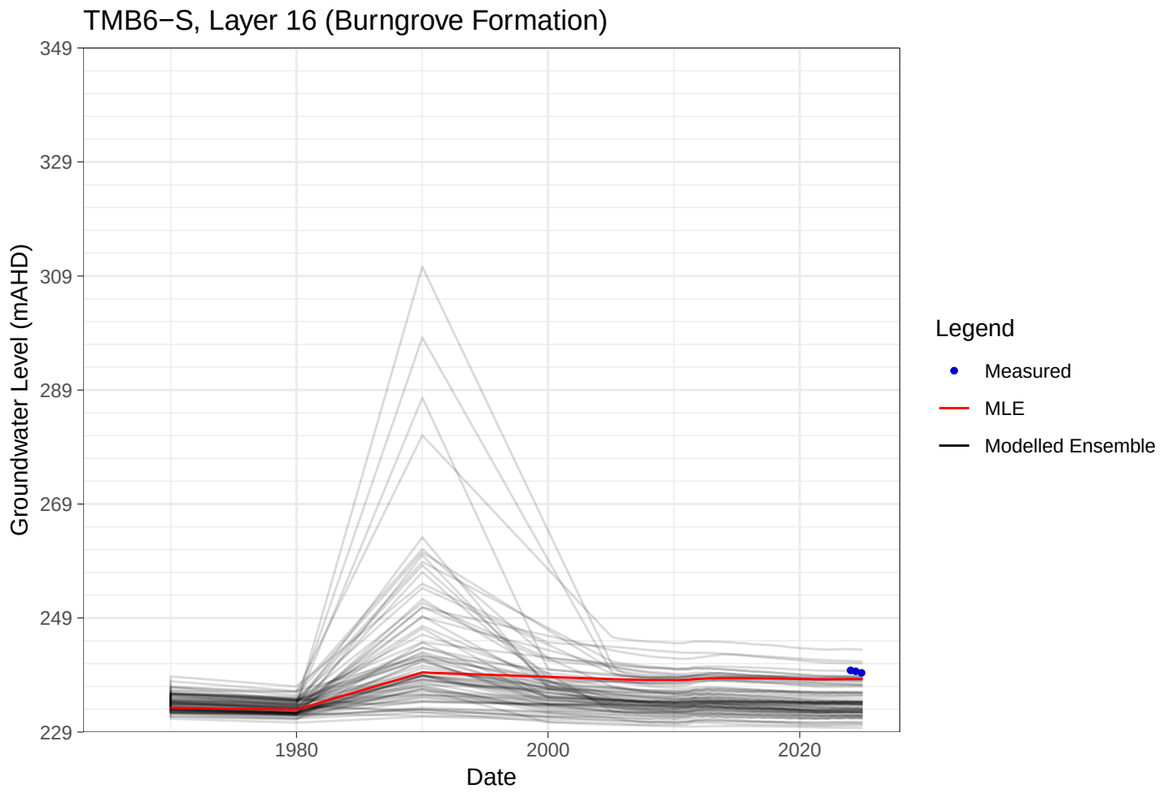

BWM_MB19_01, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
264
260
256
252
248
244
240
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

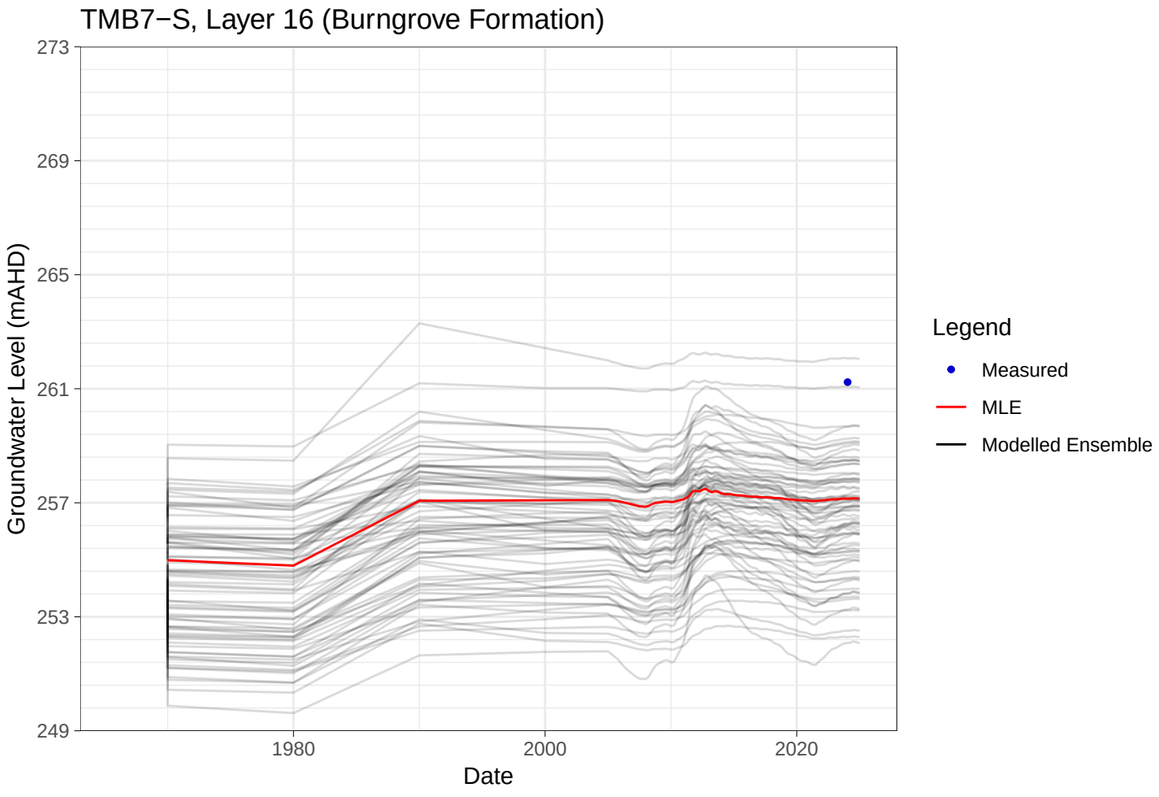

MB23, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
278
276
274
272
270
268
266
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

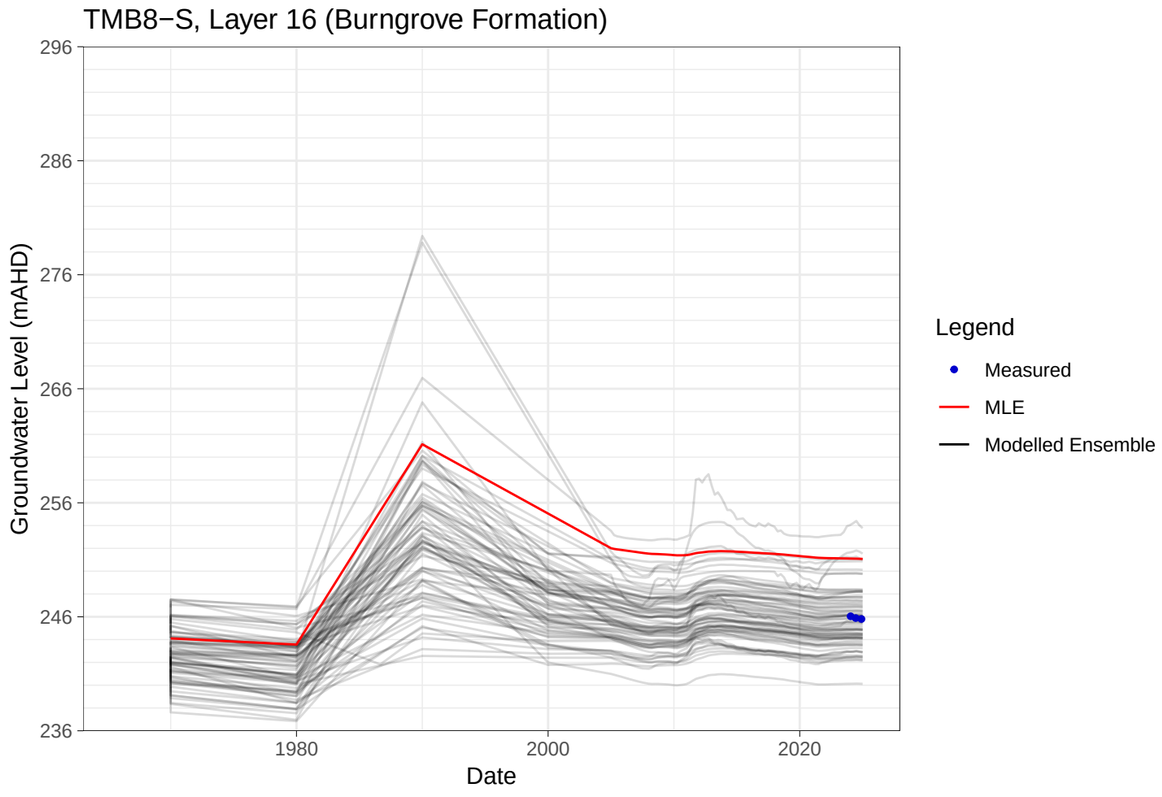

MB9, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
247
245
243
241
239
237
235
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

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TMB1−D, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
256
254
252
250
248
246
244
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble


TMB6−S, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
349
329
309
289
269
249
229
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble


TMB7−S, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
273
269
265
261
257
253
249
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble


TMB8−S, Layer 16 (Burngrove Formation)
Groundwater Level (mAHD)
296
286
276
266
256
246
236
1980
2000
2020
Date
Legend
Measured
MLE
Modelled Ensemble

Appendix C Predictive Period Timing

Blackwater North Extension Project

Groundwater Modelling Technical Report

Whitehaven Blackwater Pty Ltd

SLR Project No.: 640.031809.00001

7 October 2026

Interval	Stress Period	Date (from)	Date (to)	Blackwater North (OC)	Blackwater South (OC)	Cook Colliery (UG)
Annually	86	01-01-2025	31-12-2025	x	x	x
Annually	87	01-01-2026	31-12-2026	x	x	x
Annually	88	01-01-2027	31-12-2027	x	x	x
Annually	89	01-01-2028	31-12-2028	x	x	x
Annually	90	01-01-2029	31-12-2029	x	x	x
Annually	91	01-01-2030	31-12-2030	x	x	x
Annually	92	01-01-2031	31-12-2031	x	x	x
Annually	93	01-01-2032	31-12-2032	x	x	x
Annually	94	01-01-2033	31-12-2033	x	x	x
Annually	95	01-01-2034	31-12-2034	x	x	x
Annually	96	01-01-2035	31-12-2035	x	x	x
Annually	97	01-01-2036	31-12-2036	x	x	x
Annually	98	01-01-2037	31-12-2037	x	x	x
Annually	99	01-01-2038	31-12-2038	x	x	x
Annually	100	01-01-2039	31-12-2039	x	x	x
Annually	101	01-01-2040	31-12-2040	x	x	x
Annually	102	01-01-2041	31-12-2041	x	x	x
Annually	103	01-01-2042	31-12-2042	x	x	x
Annually	104	01-01-2043	31-12-2043	x	x	x
Annually	105	01-01-2044	31-12-2044	x	x	x
Annually	106	01-01-2045	31-12-2045	x	x	x
Annually	107	01-01-2046	31-12-2046	x	x	x
Annually	108	01-01-2047	31-12-2047	x	x	x
Annually	109	01-01-2048	31-12-2048	x	x	x
Annually	110	01-01-2049	31-12-2049	x	x	x
Annually	111	01-01-2050	31-12-2050	x	x	x
Annually	112	01-01-2051	31-12-2051	x	x	x
Annually	113	01-01-2052	31-12-2052	x	x	x
Annually	114	01-01-2053	31-12-2053	x	x	x
Annually	115	01-01-2054	31-12-2054	x	x	x
Annually	116	01-01-2055	31-12-2055	x	x	x
Annually	117	01-01-2056	31-12-2056		x	x
Annually	118	01-01-2057	31-12-2057		x	x
Annually	119	01-01-2058	31-12-2058		x	x
Annually	120	01-01-2059	31-12-2059		x	x
Annually	121	01-01-2060	31-12-2060		x	x



Interval	Stress Period	Date (from)	Date (to)	Blackwater North (OC)	Blackwater South (OC)	Cook Colliery (UG)
Annually	122	01-01-2061	31-12-2061		x	x
Annually	123	01-01-2062	31-12-2062		x	x
Annually	124	01-01-2063	31-12-2063		x	x
Annually	125	01-01-2064	31-12-2064		x	x
Annually	126	01-01-2065	31-12-2065		x	x
Annually	127	01-01-2066	31-12-2066		x	x
Annually	128	01-01-2067	31-12-2067		x	x
Annually	129	01-01-2068	31-12-2068		x	x
Annually	130	01-01-2069	31-12-2069		x	x
Annually	131	01-01-2070	31-12-2070		x	x
Annually	132	01-01-2071	31-12-2071		x	x
Annually	133	01-01-2072	31-12-2072		x	x
Annually	134	01-01-2073	31-12-2073		x	x
Annually	135	01-01-2074	31-12-2074		x	x
Annually	136	01-01-2075	31-12-2075		x	x
Annually	137	01-01-2076	31-12-2076		x	x
Annually	138	01-01-2077	31-12-2077		x	x
Annually	139	01-01-2078	31-12-2078		x	
Annually	140	01-01-2079	31-12-2079		x	
Annually	141	01-01-2080	31-12-2080		x	
Annually	142	01-01-2081	31-12-2081		x	
Annually	143	01-01-2082	31-12-2082		x	
Annually	144	01-01-2083	31-12-2083		x	
Annually	145	01-01-2084	31-12-2084		x	
Annually	146	01-01-2085	31-12-2085		x	
Annually	147	01-01-2086	31-12-2086		x	
Annually	148	01-01-2087	31-12-2087		x	
Annually	149	01-01-2088	31-12-2088		x	
Annually	150	01-01-2089	31-12-2089		x	
Annually	151	01-01-2090	31-12-2090		x	
Annually	152	01-01-2091	31-12-2091		x	
Annually	153	01-01-2092	31-12-2092		x	
Annually	154	01-01-2093	31-12-2093		x	

Appendix D Post-mining predicted water levels

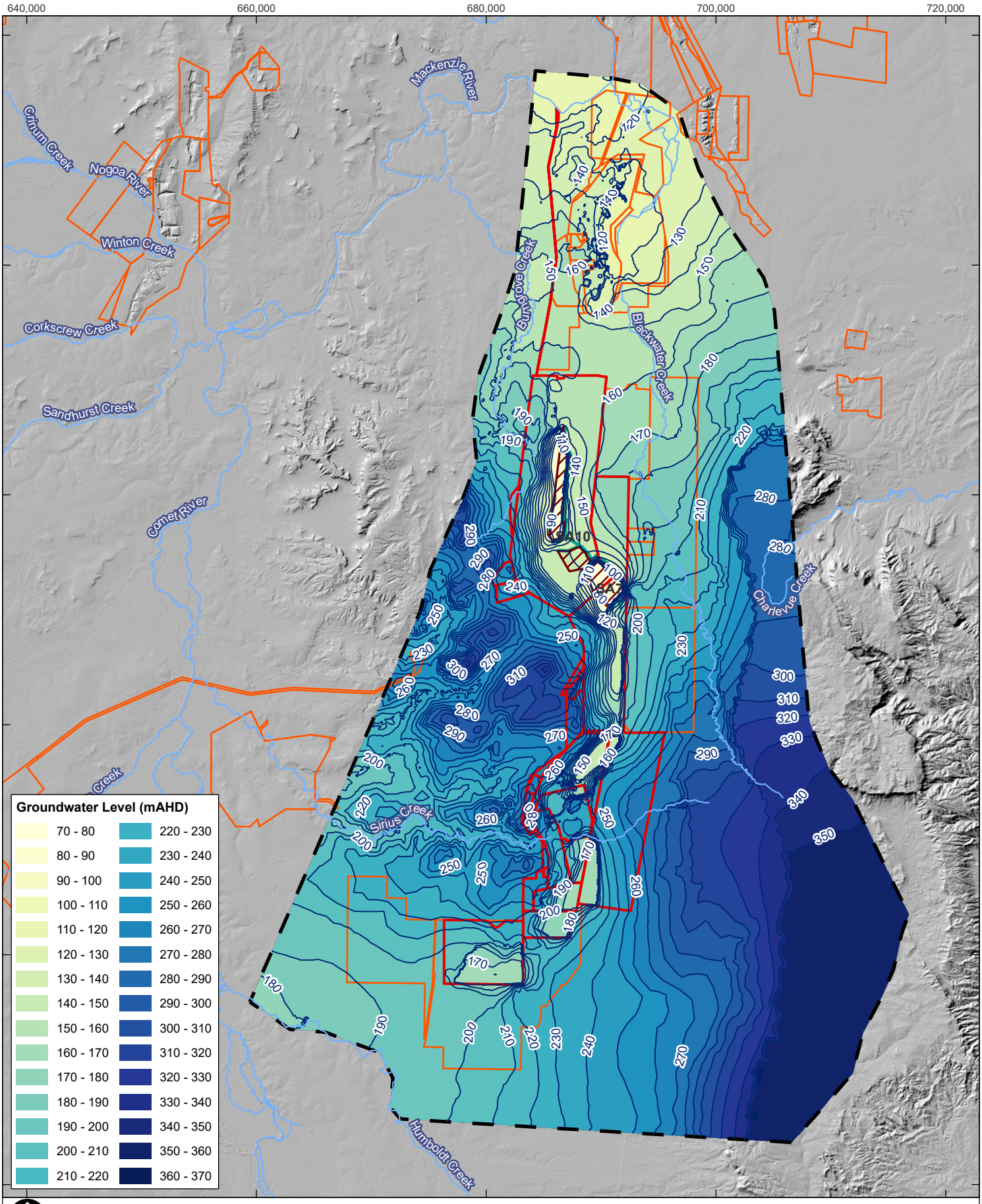
Blackwater North Extension Project

Groundwater Modelling Technical Report

Whitehaven Blackwater Pty Ltd

SLR Project No.: 640.031809.00001

7 October 2026



0 5 10 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:433,846 at A4
Project Number:	640.031809.00001
Date Drawn:	16-Feb-2026
Drawn by:	RB

LEGEND

- Groundwater Level Contour (m)
- Watercourse
- BWM Mining Lease
- Mining Lease
- GIA Study Area
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER ASSESSMENT

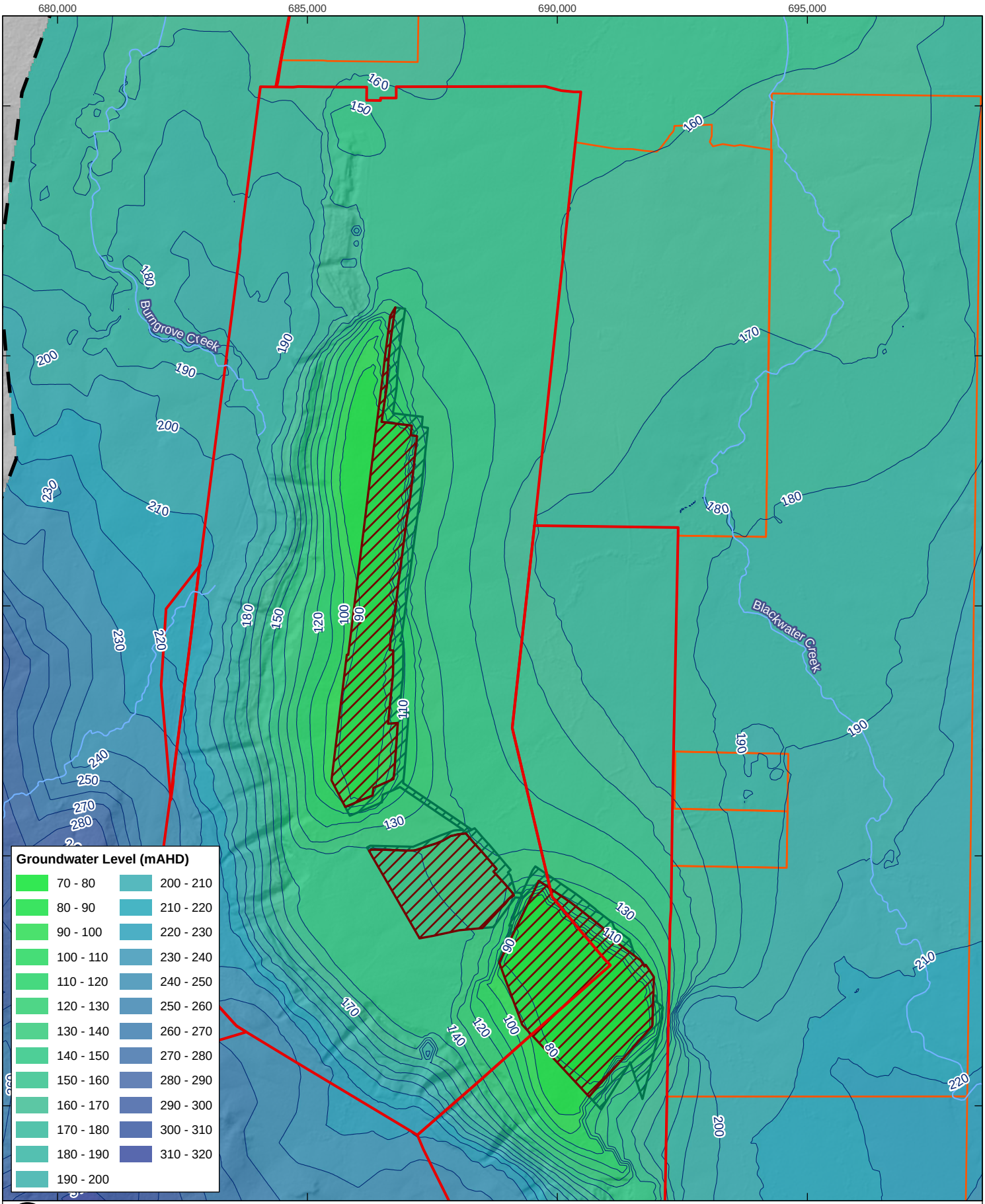
GROUNDWATER TABLE RECOVERY (POST-MINING)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE D-1

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_F05_08_Groundwater Table Recovery (post-mining)



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	640.031809.00001
Date Drawn:	20-Aug-2026
Drawn by:	RB

LEGEND

- Groundwater Level Contour (m)
- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

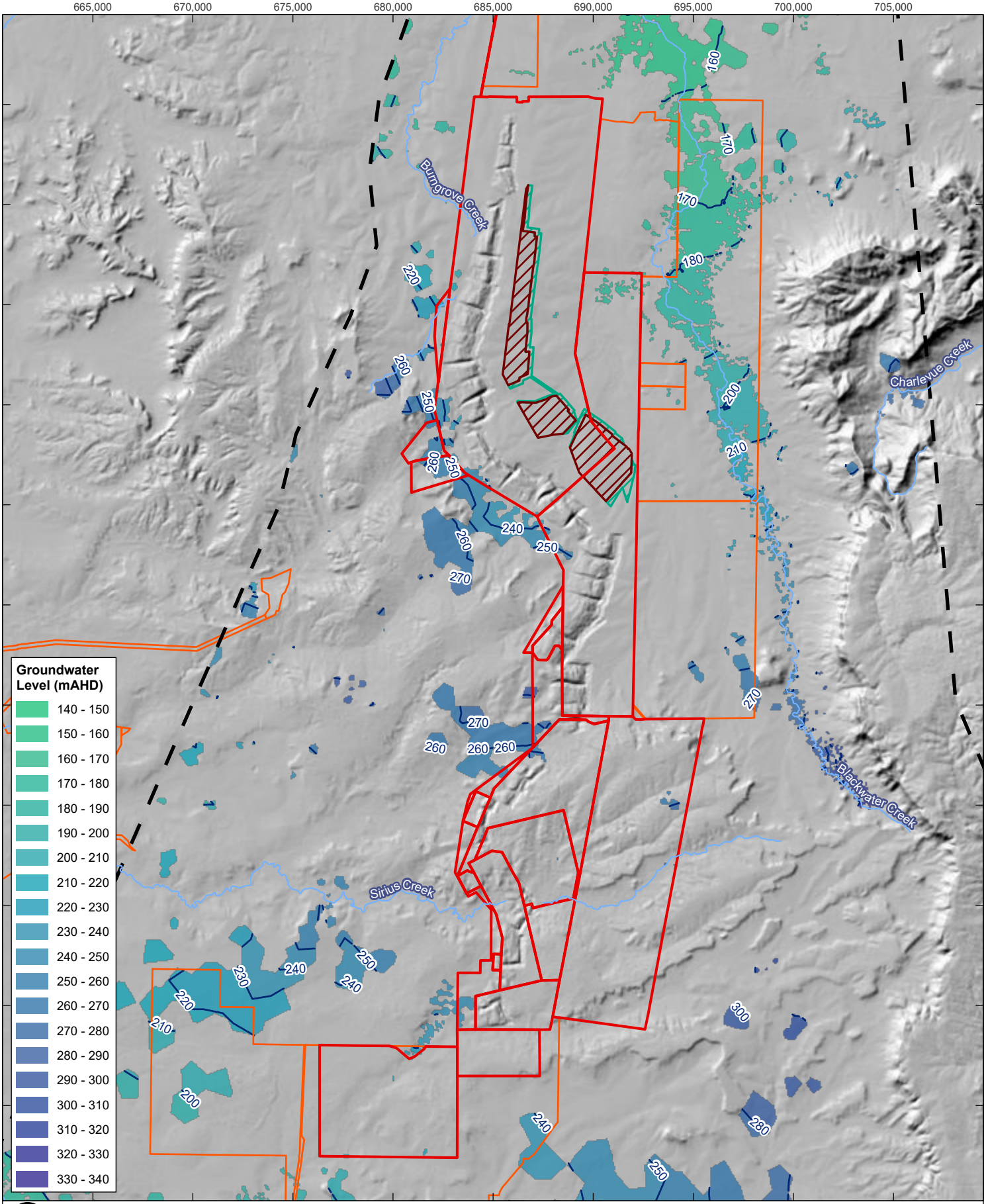
GROUNDWATER TABLE RECOVERY (POST-MINING) - NORTHERN VOIDS

SLR

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FIGURE D-2

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_FXX_Groundwater Table Recovery (post-mining)



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	20-Aug-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Contour (mAHD)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

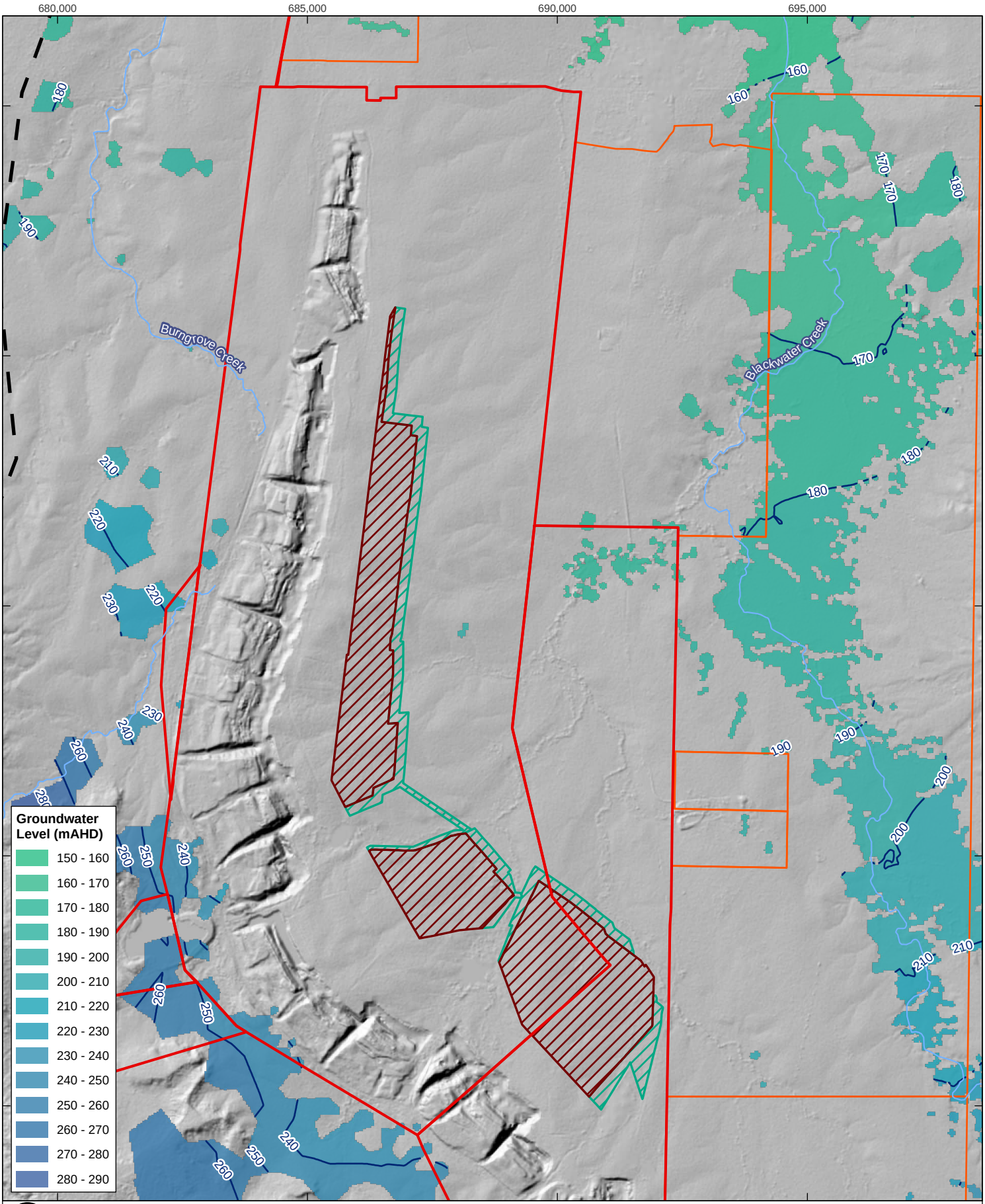
PREDICTED WATER LEVEL
WITHIN TERTIARY SEDIMENTS (LAYER 1)
AT POST-MINING EQUILIBRATED

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE D-3

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	640.031809.00001
Date Drawn:	19-Aug-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Contour (mAHD)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

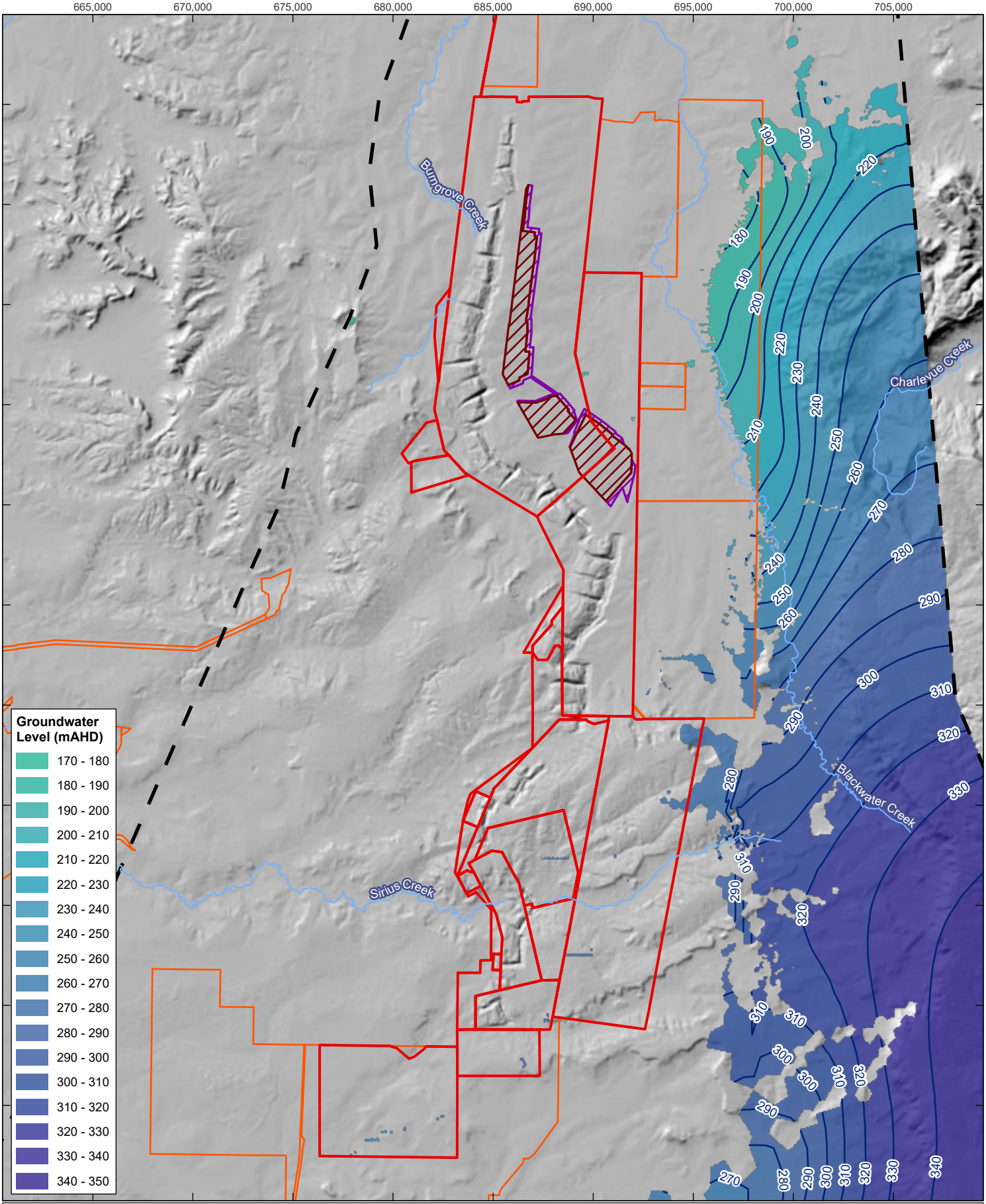
PREDICTED WATER LEVEL WITHIN TERTIARY SEDIMENTS (LAYER 1) AT POST-MINING EQUILIBRATED - NORTHERN VOIDS

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE D-4

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_FXX_Predicted Water Level within Tertiary Sediments (Layer 1) at PME



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	20-Aug-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Contour (mAHD)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

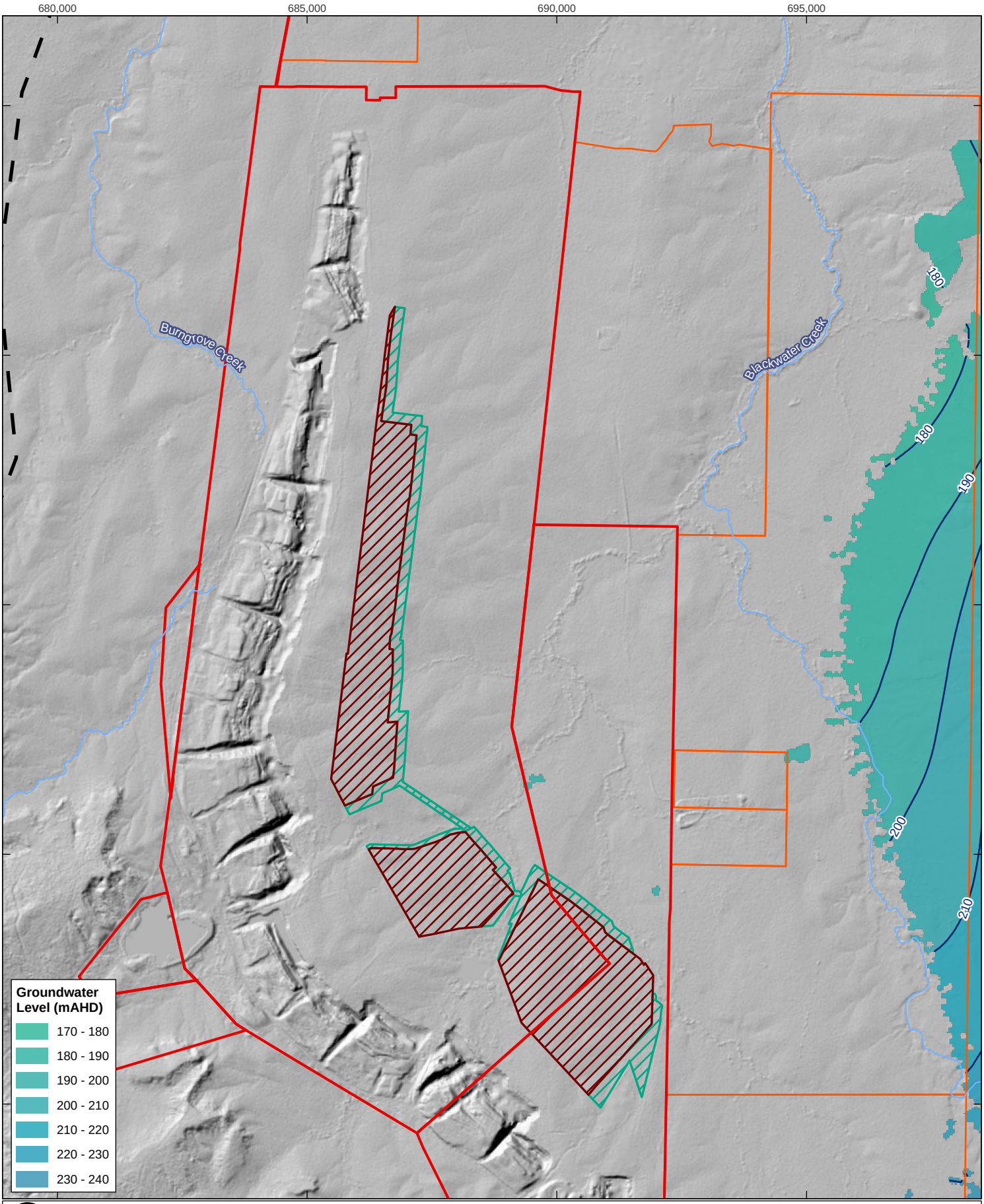
PREDICTED WATER LEVEL
WITHIN REWAN FORMATION - UPPER (LAYER 4)
AT POST-MINING EQUILIBRATED

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE D-5

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	640.031809.00001
Date Drawn:	19-Aug-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Contour (mAHD)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

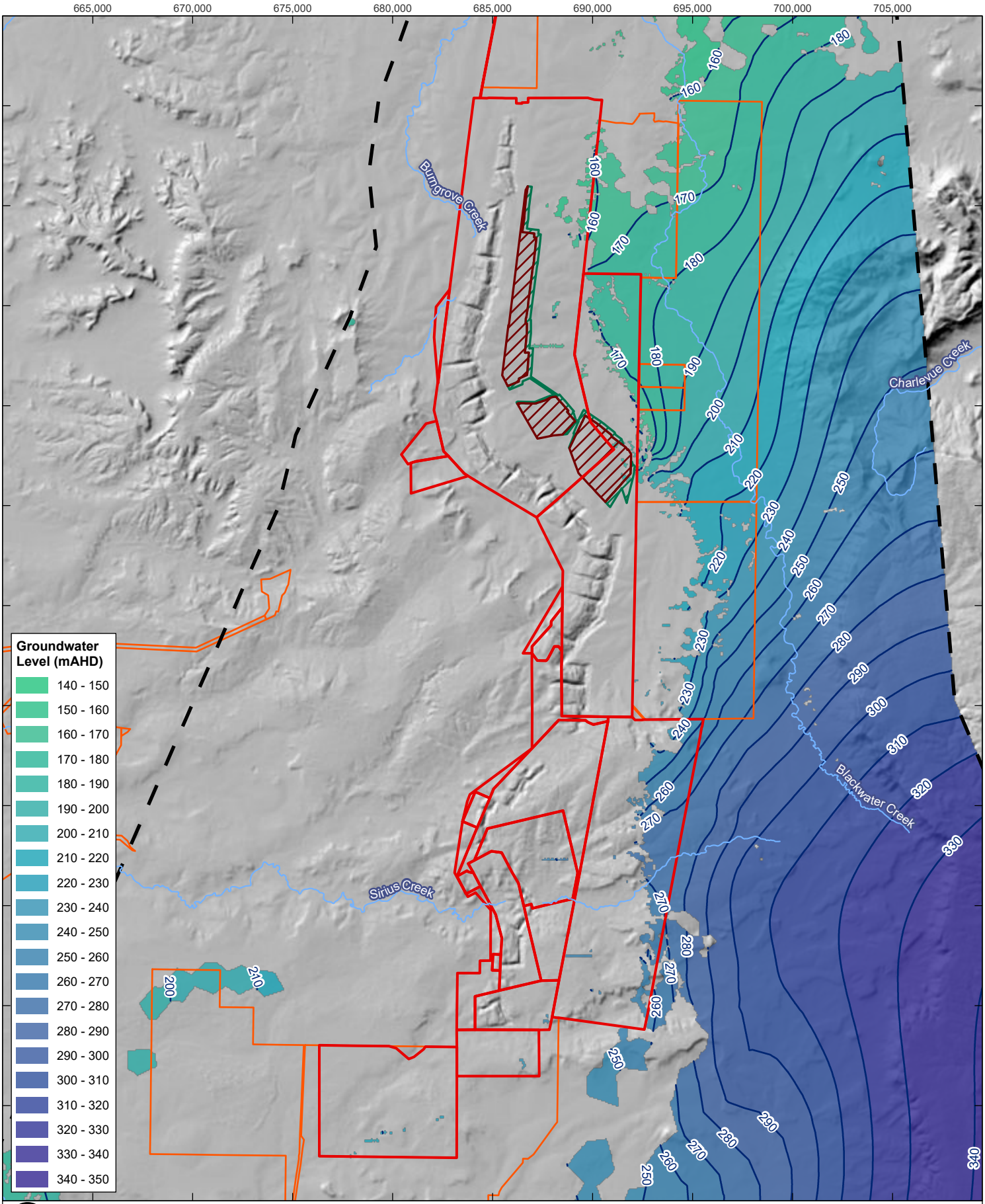
PREDICTED WATER LEVEL WITHIN REWAN FORMATION - UPPER (LAYER 4) AT POST-MINING EQUILIBRATED - NORTHERN VOIDS

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE D-6

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_FXX_Predicted Water Level within Rewan Formation - Upper (Layer 4) at PME



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	20-Aug-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Contour (mAHD)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

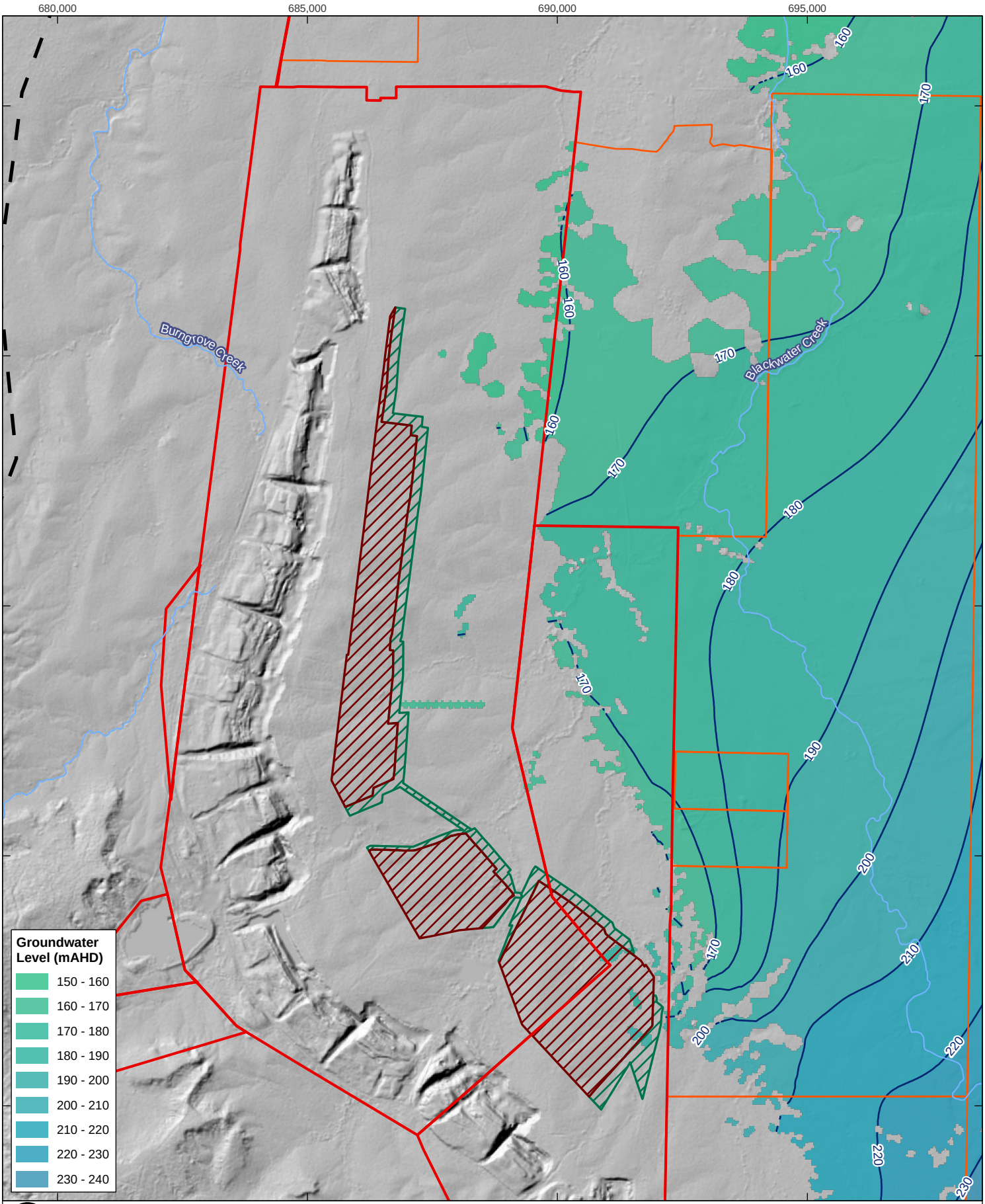
PREDICTED WATER LEVEL
WITHIN REWAN FORMATION - MIDDLE (LAYER 5)
AT POST-MINING EQUILIBRATED

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE D-7

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	640.031809.00001
Date Drawn:	19-Aug-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Contour (mAHD)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

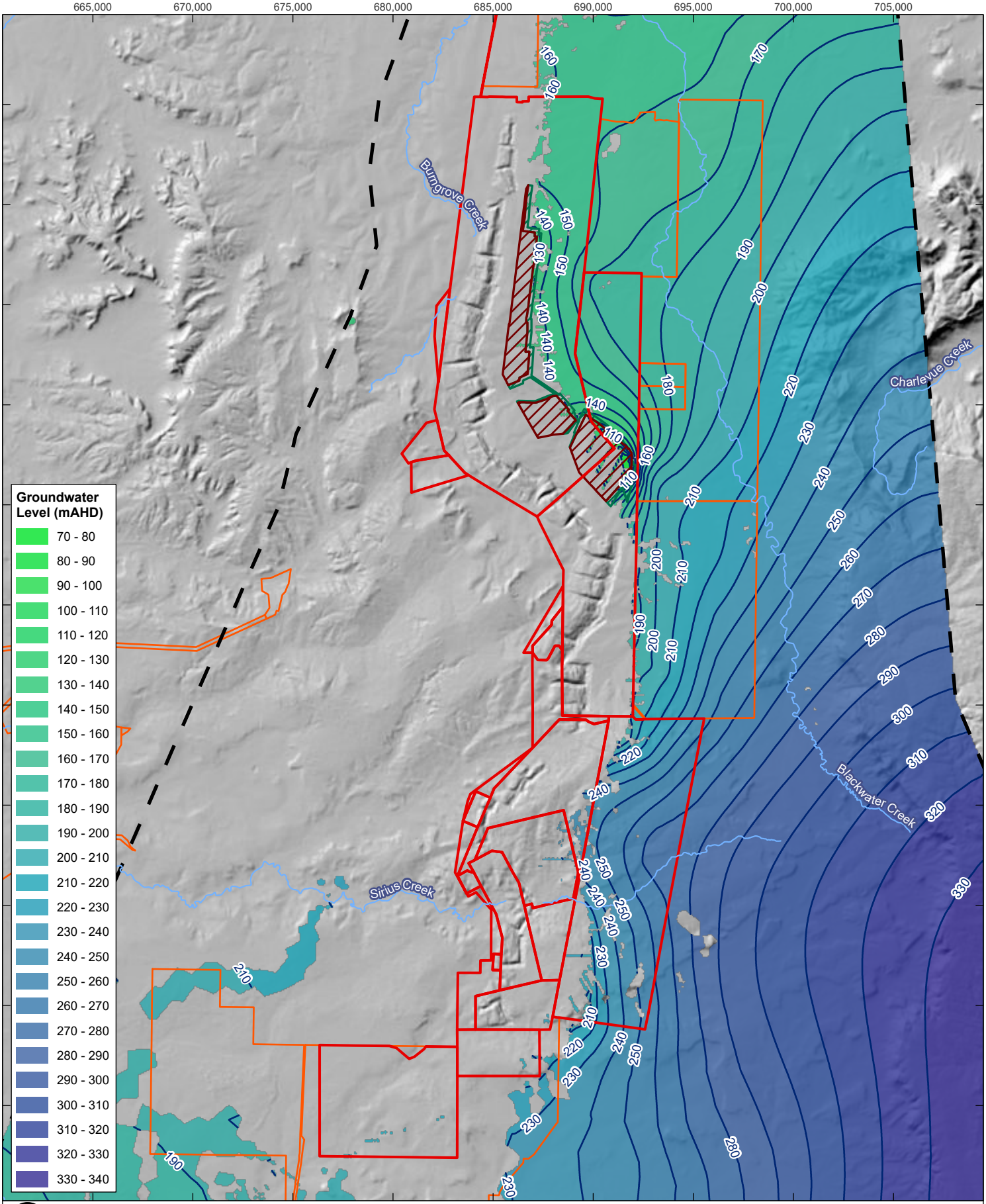
PREDICTED WATER LEVEL WITHIN REWAN FORMATION - MIDDLE (LAYER 5) AT POST-MINING EQUILIBRATED - NORTHERN VOIDS

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE D-8

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_FXX_Predicted Water Level within Rewan Formation - Middle (Layer 5) at PME



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	20-Aug-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Contour (mAHD)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

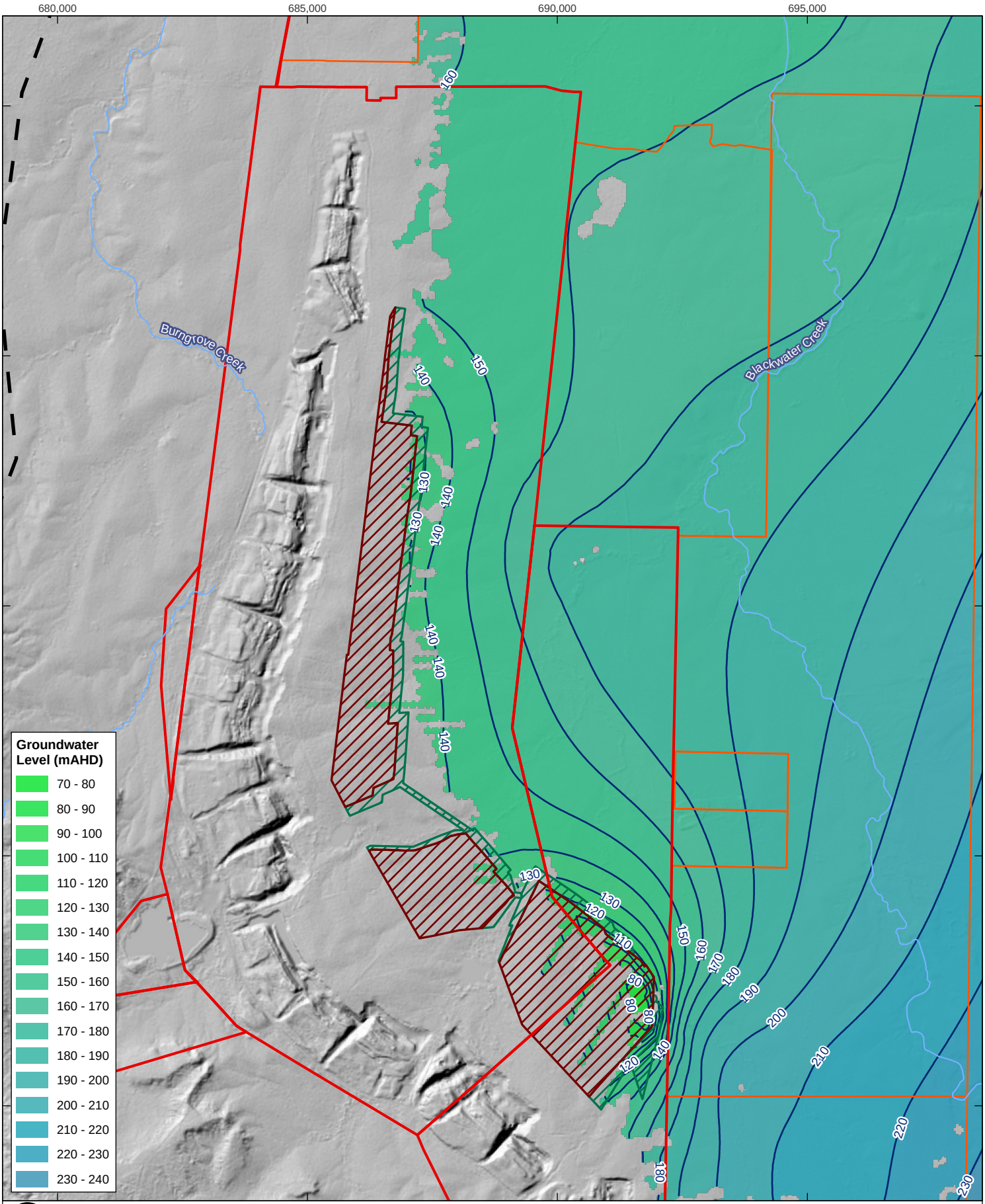
PREDICTED WATER LEVEL
WITHIN REWAN FORMATION - LOWER (LAYER 6)
AT POST-MINING EQUILIBRATED

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE D-9

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	640.031809.00001
Date Drawn:	19-Aug-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Contour (mAHD)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

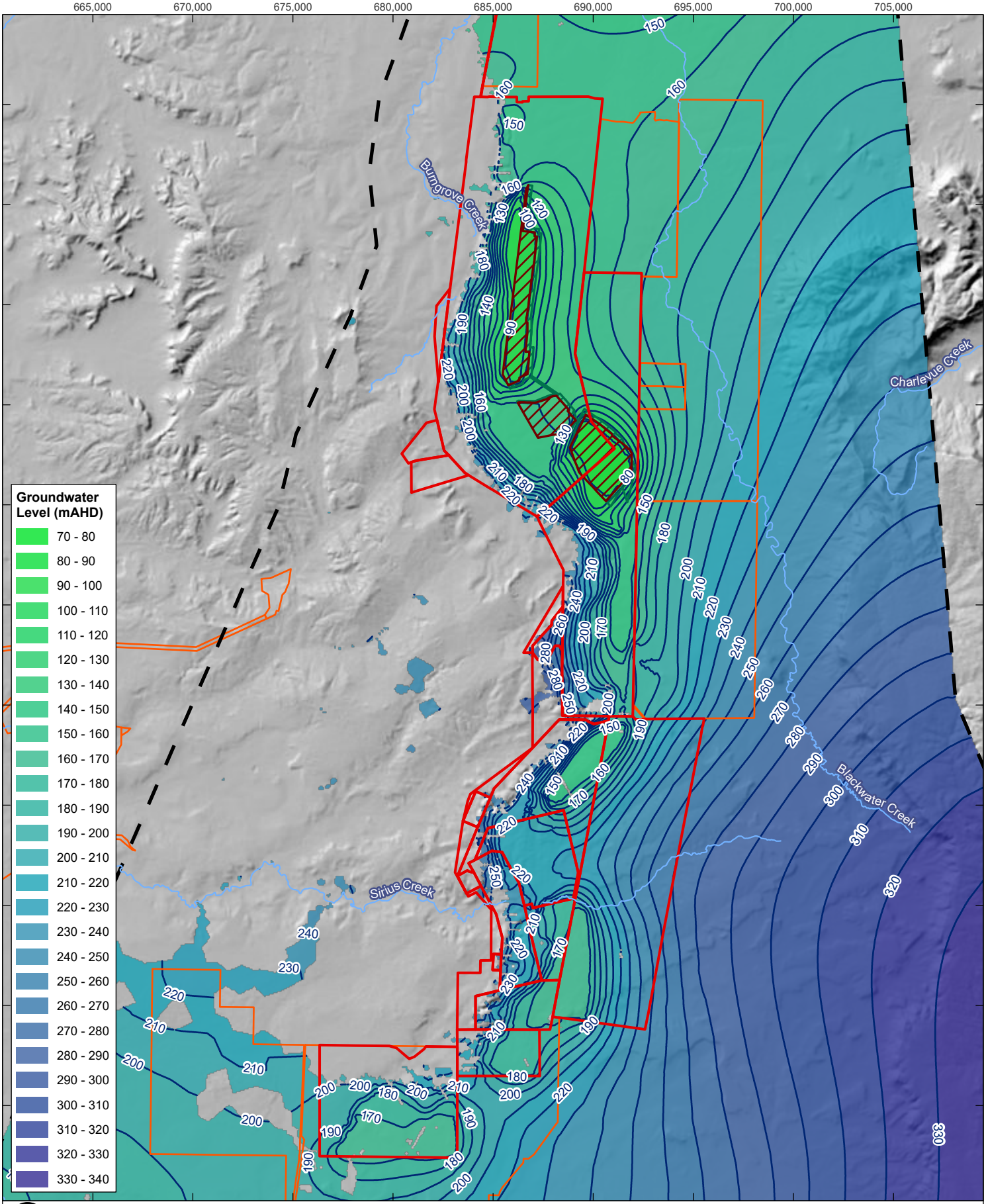
PREDICTED WATER LEVEL
WITHIN REWAN FORMATION - LOWER (LAYER 6)
AT POST-MINING EQUILIBRATED
- NORTHERN VOIDS

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE D-10

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_FXX_Predicted Water Level within Rewan Formation - Lower (Layer 6) at PME



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	20-Aug-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Contour (mAHD)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

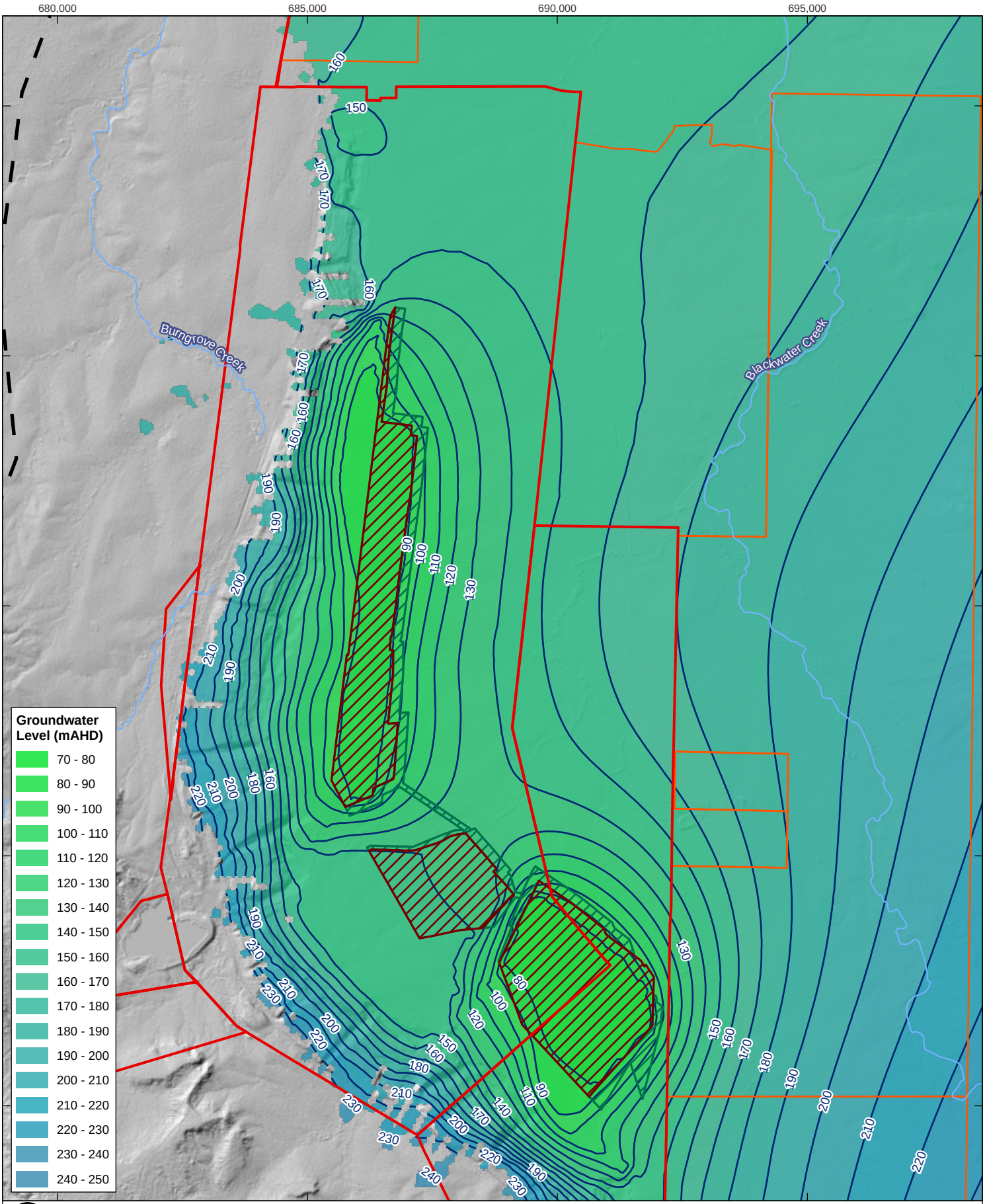
PREDICTED WATER LEVEL WITHIN RCM REPRESENTATIVE COAL SEAM (POLLUX) (LAYER 12) AT POST-MINING EQUILIBRATED

SLR

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FIGURE D-11

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	640.031809.00001
Date Drawn:	19-Aug-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Contour (mAHD)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

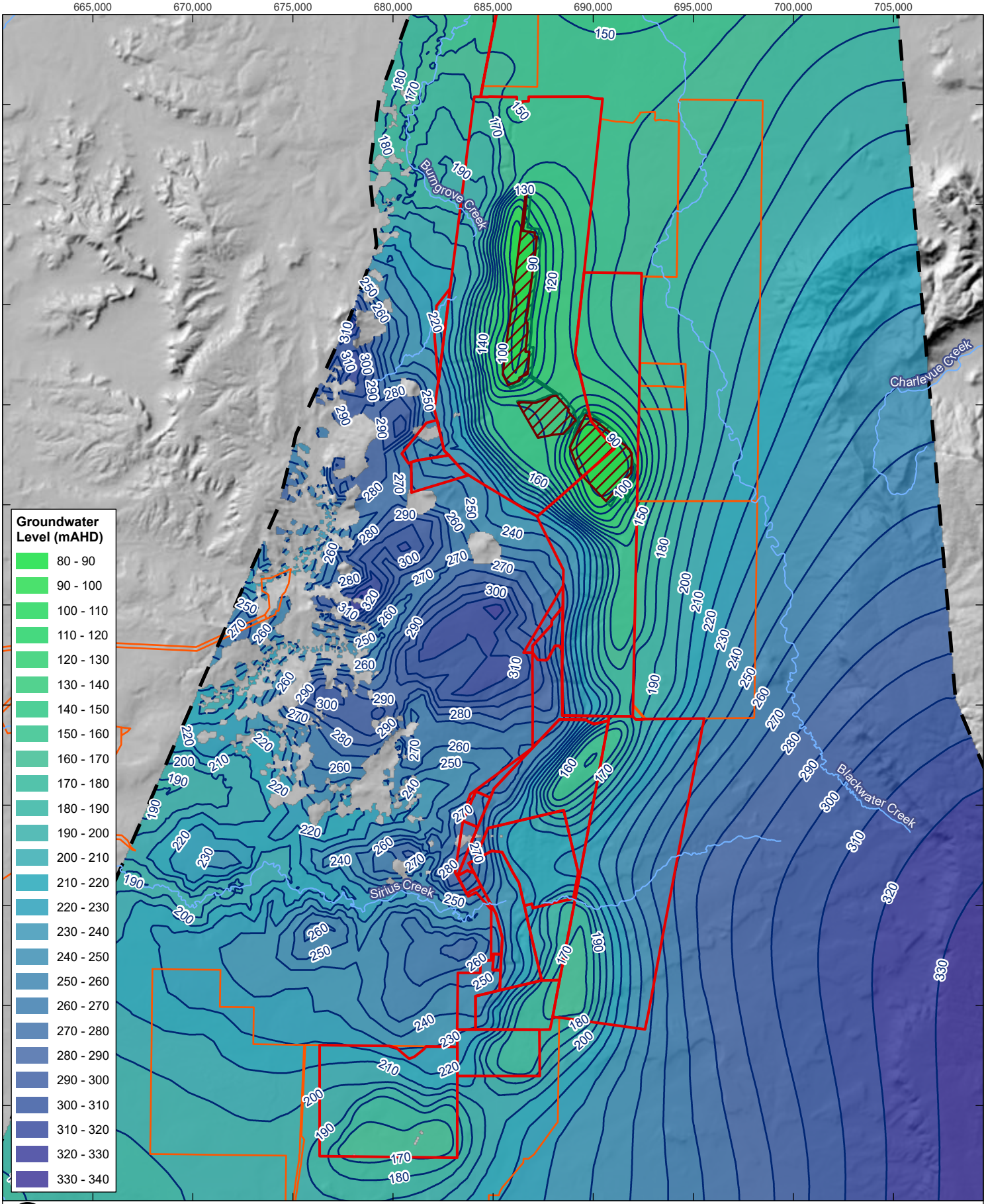
PREDICTED WATER LEVEL WITHIN RCM REPRESENTATIVE COAL SEAM (POLLUX) (LAYER 12) AT POST-MINING EQUILIBRATED - NORTHERN VOIDS

SLR

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FIGURE D-12

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_FXX_Predicted Water Level within RCM Pollux (Layer 12) at PME



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	20-Aug-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Contour (mAHD)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

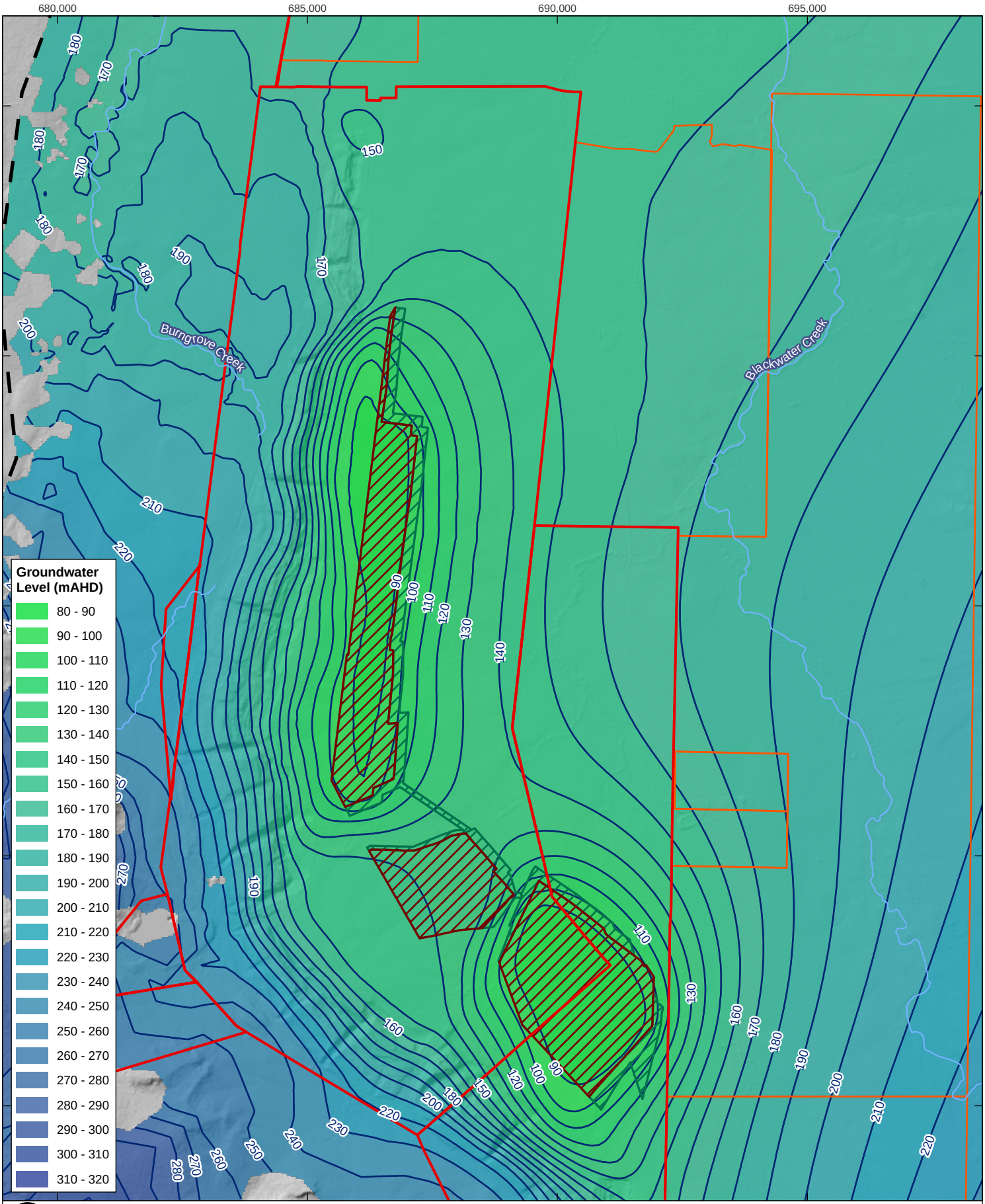
PREDICTED WATER LEVEL WITHIN BURNGROVE FORMATION (LAYER 16) AT POST-MINING EQUILIBRATED

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE D-13

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	640.031809.00001
Date Drawn:	19-Aug-2026
Drawn by:	AS

LEGEND

- Watercourse
- Groundwater Contour (mAHD)
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

PREDICTED WATER LEVEL WITHIN BURNGROVE FORMATION (LAYER 16) AT POST-MINING EQUILIBRATED - NORTHERN VOIDS

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE D-14

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_FXX_Predicted Water Level within Burngrove Formation (Layer 16) at PME

Appendix E Parameter Distribution Plots for Sampled Prior and Calibrated Ensemble

Blackwater North Extension Project

Groundwater Modelling Technical Report

Whitehaven Blackwater Pty Ltd

SLR Project No.: 640.031809.00001

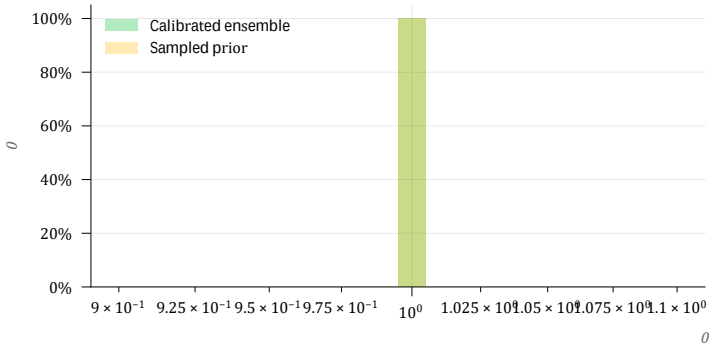
7 October 2026


evtf_z01
evtf_z02
evtf_z03
evtf_z04
exdp_z01
exdp_z02
exdp_z03
exdp_z04
kx_z01
kx_z02
Calibrated ensemble
Sampled prior
0
Parameters

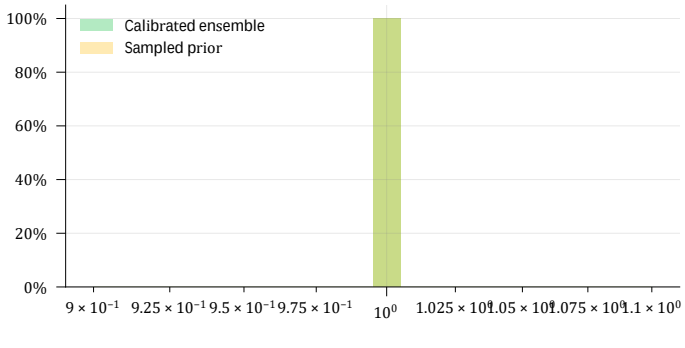

kx_z03
kx_z04
kx_z05
kx_z06
kx_z07
kx_z08
kx_z09
kx_z10
kx_z11
kx_z12
Calibrated ensemble
Sampled prior
0
Parameters


kx_z13
kx_z14
kx_z15
kx_z16
kx_z17
kx_z18
kx_z19
kzf_z01
kzf_z02
kzf_z03
Calibrated ensemble
Sampled prior
Parameters

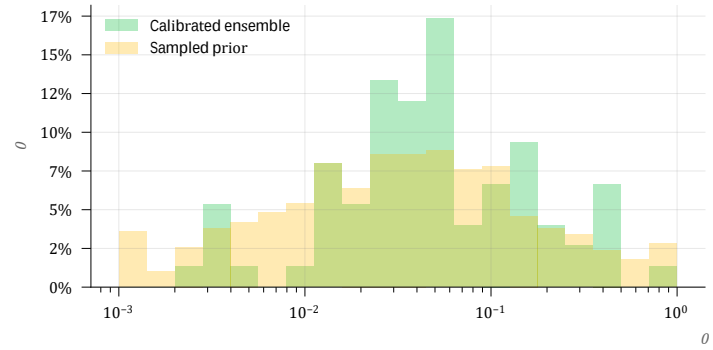
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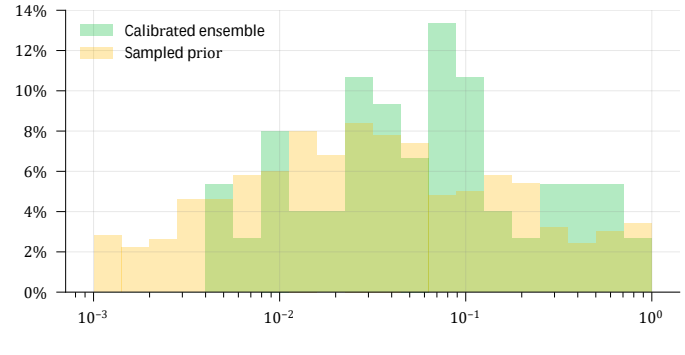
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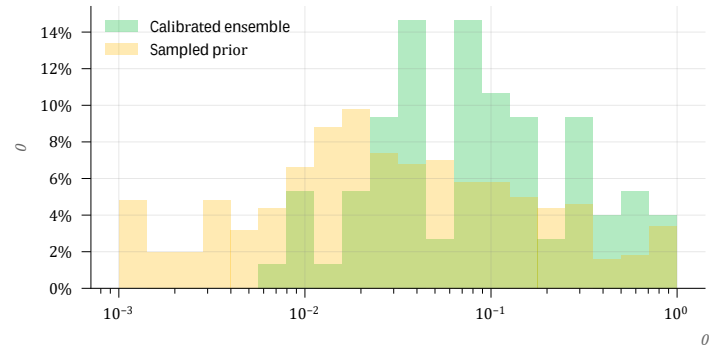
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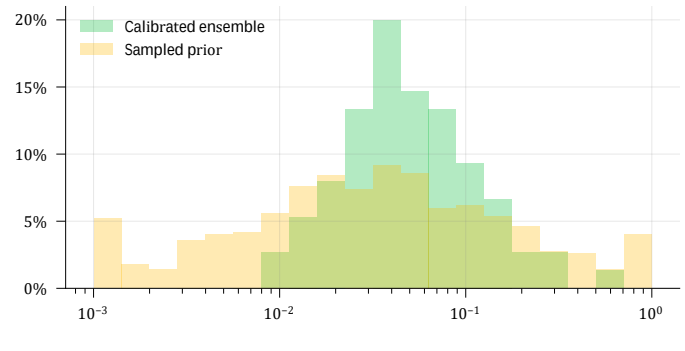
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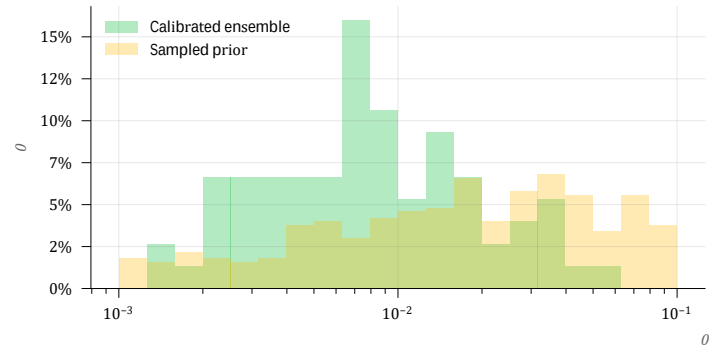
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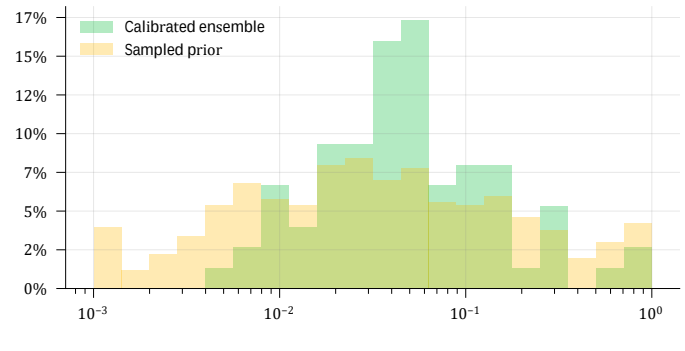
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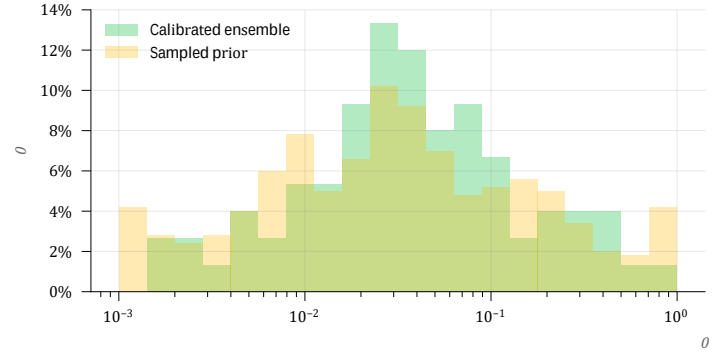
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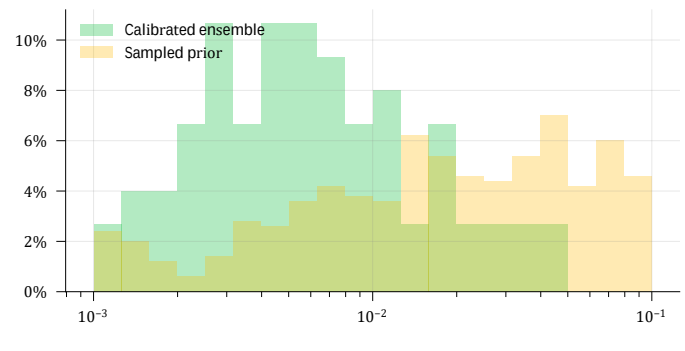
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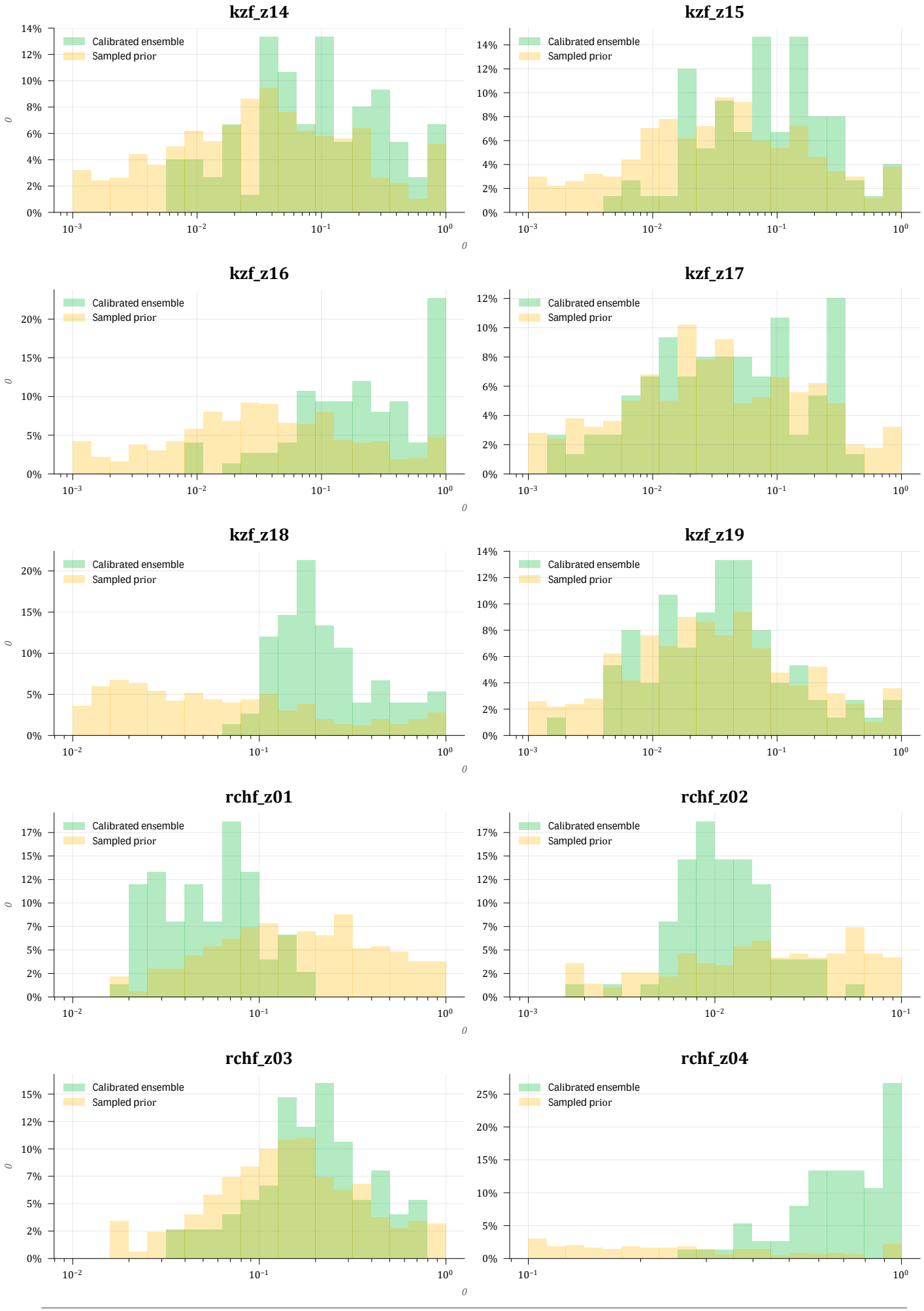


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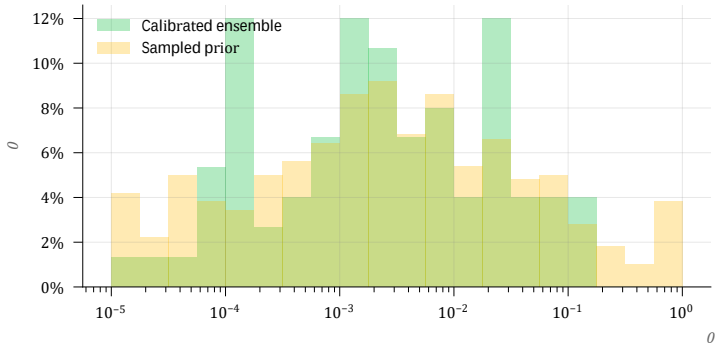


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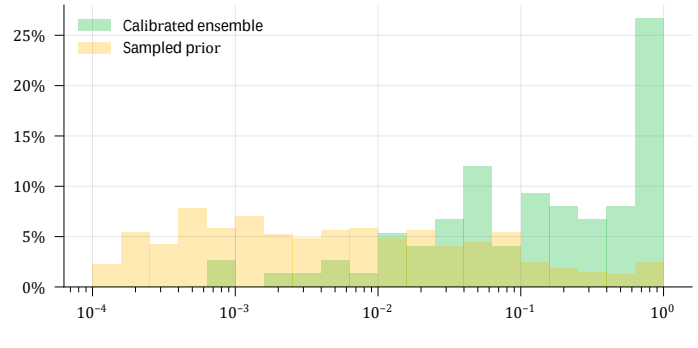



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kzf_z17
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rchf_z03
rchf_z04
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Sampled prior
Parameters

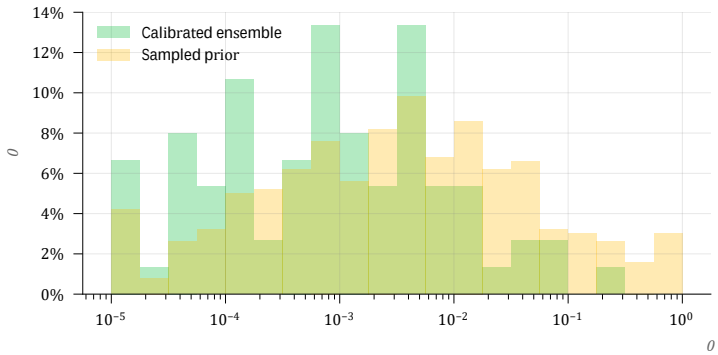
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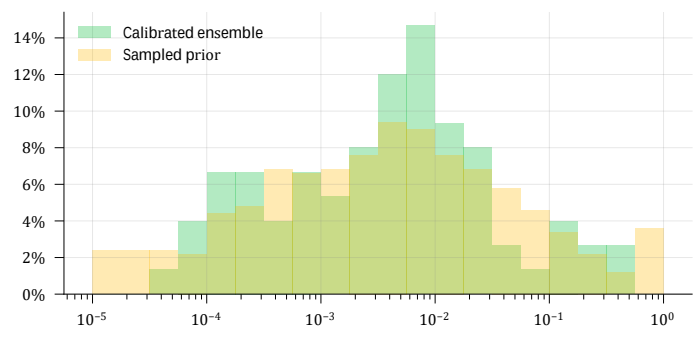
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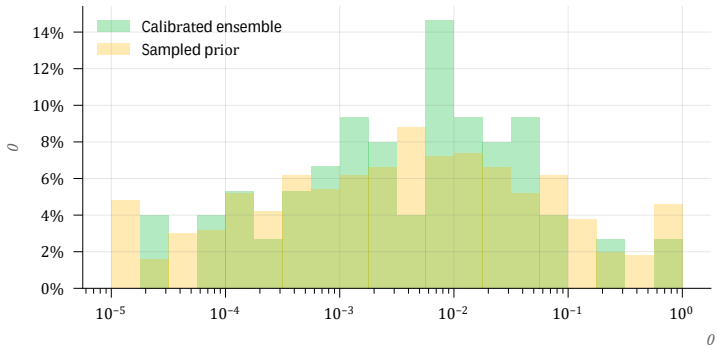
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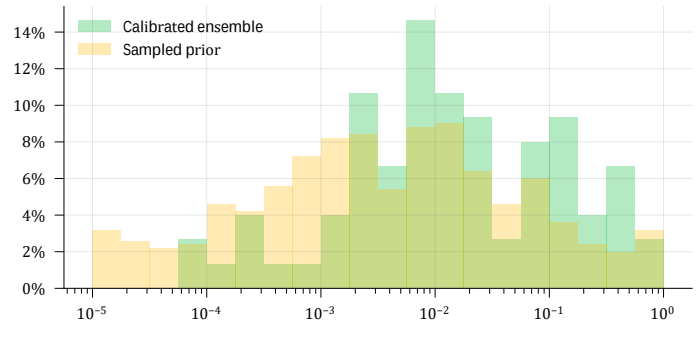
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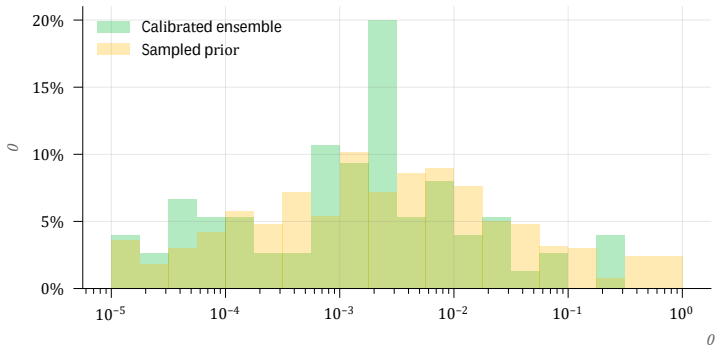
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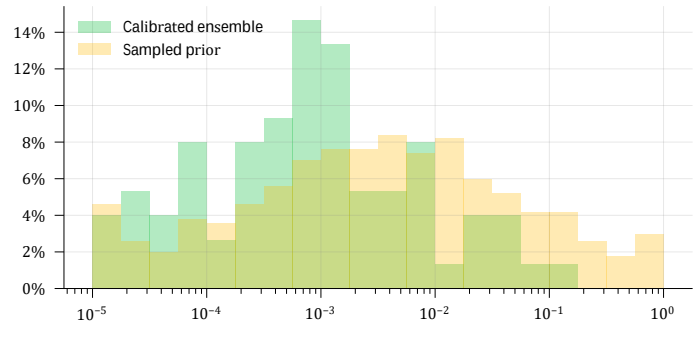
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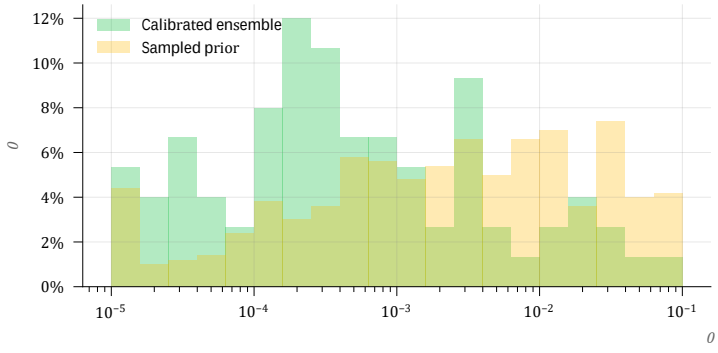
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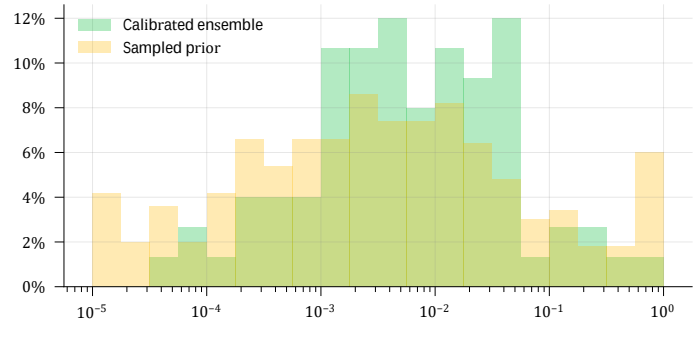
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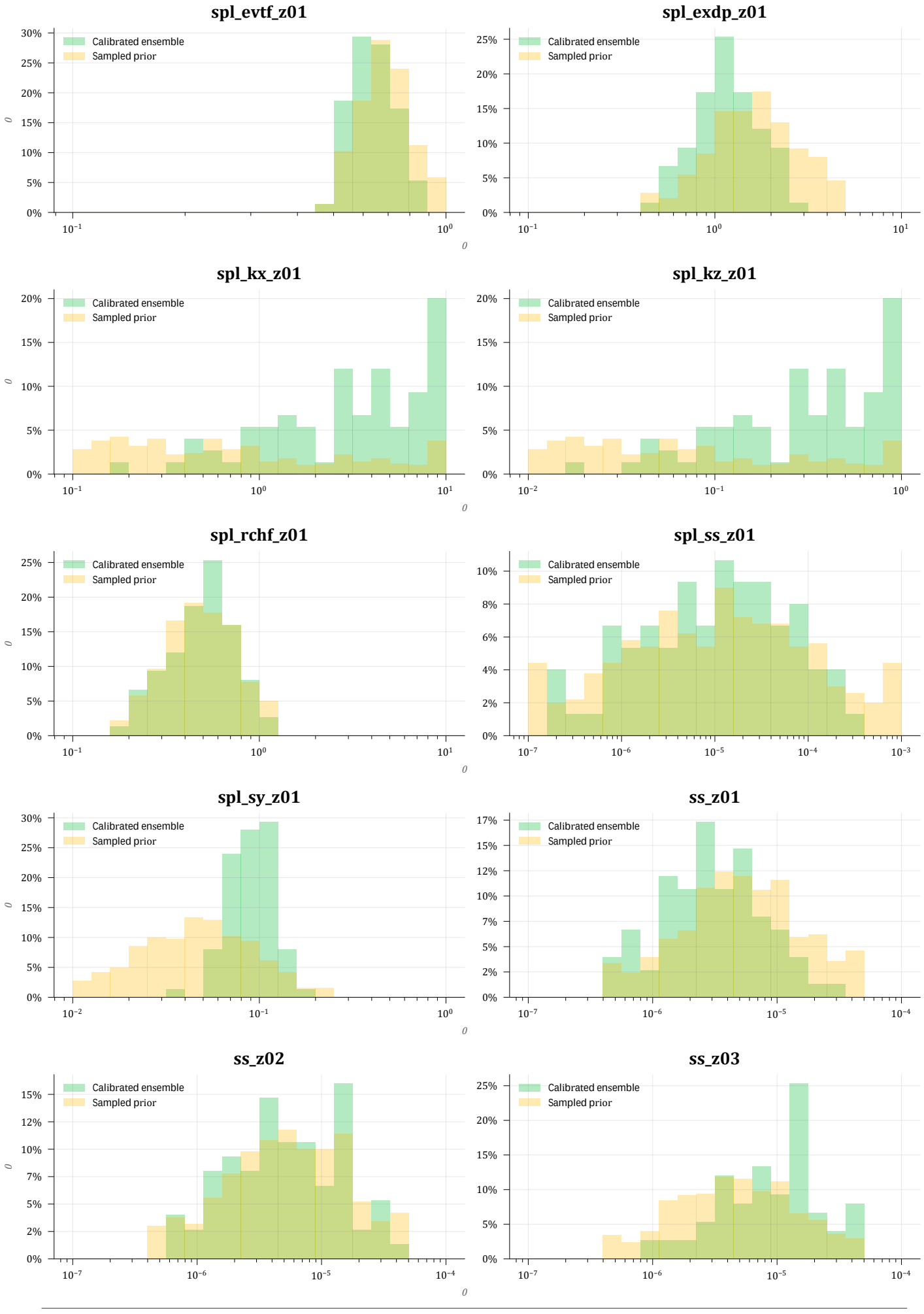


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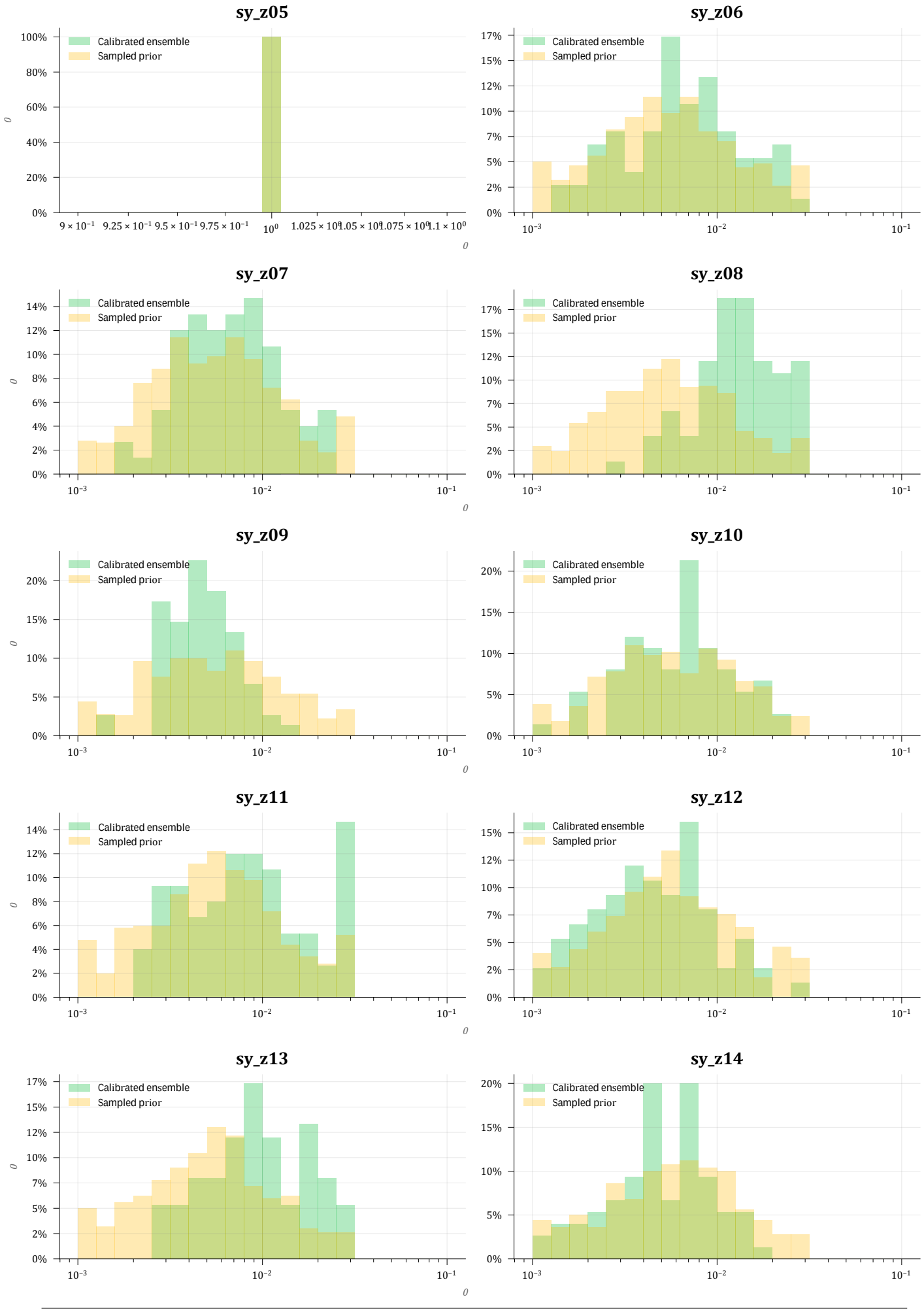
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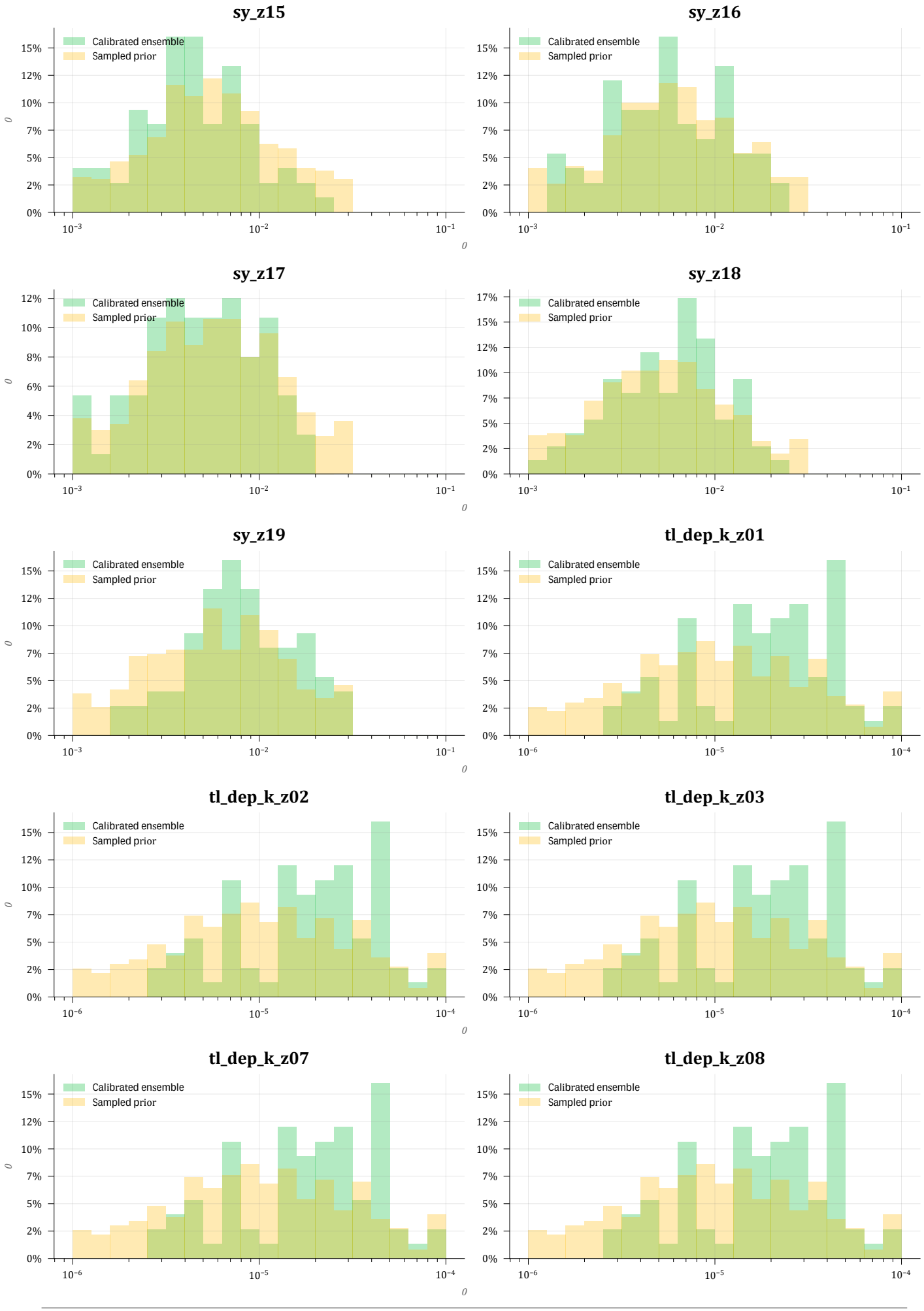


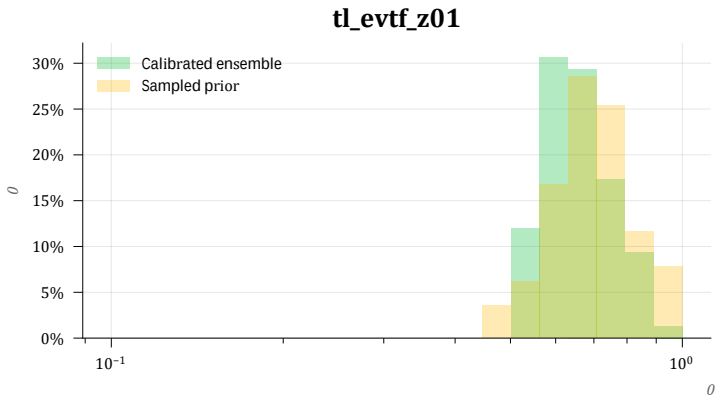

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spl_exdp_z01
spl_kx_z01
spl_kz_z01
spl_rchf_z01
spl_ss_z01
spl_sy_z01
ss_z01
ss_z02
ss_z03
Calibrated ensemble
Sampled prior
0
Parameters

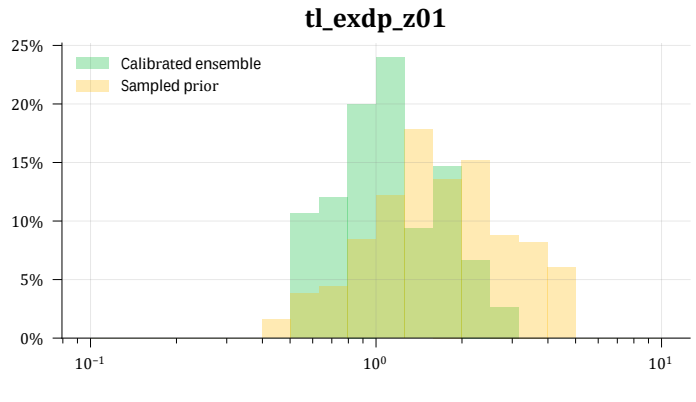

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ss_z05
ss_z06
ss_z07
ss_z08
ss_z09
ss_z10
ss_z11
ss_z12
ss_z13
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Sampled prior
0
Parameters

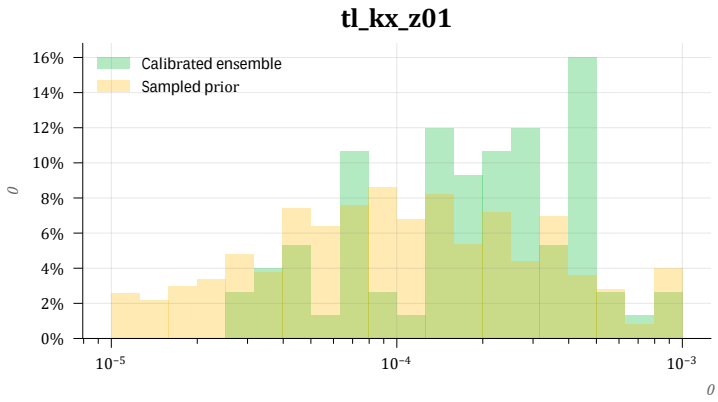

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ss_z15
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sy_z01
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sy_z03
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Calibrated ensemble
Sampled prior
Parameters

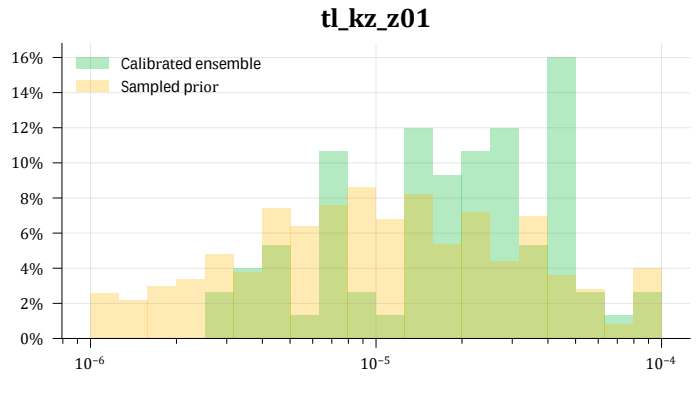

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sy_z12
sy_z13
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Sampled prior
Parameters

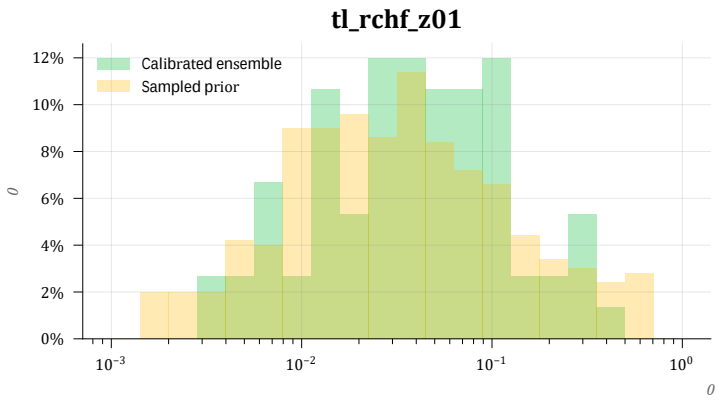

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tl_dep_k_z08
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Sampled prior
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Parameters

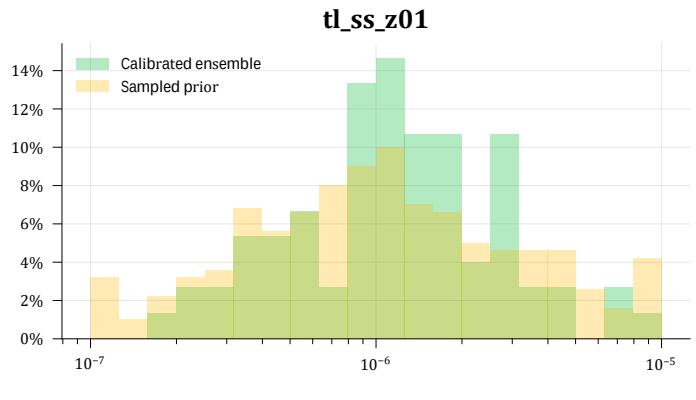

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20%
15%
10%
5%
0%
0
10^{-1}
10^{0}
0

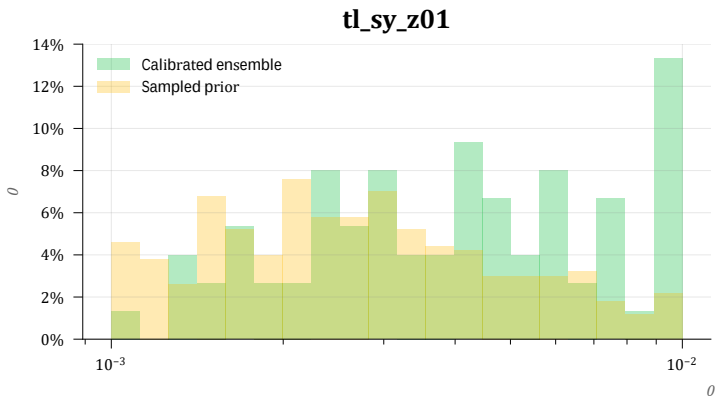

tl_exdp_z01
Calibrated ensemble
Sampled prior
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20%
15%
10%
5%
0%
10^{-1}
10^{0}
10^{1}


tl_kx_z01
Calibrated ensemble
Sampled prior
16%
14%
12%
10%
8%
6%
4%
2%
0%
0
10^{-5}
10^{-4}
10^{-3}
0


tl_kz_z01
Calibrated ensemble
Sampled prior
16%
14%
12%
10%
8%
6%
4%
2%
0%
10^{-6}
10^{-5}
10^{-4}


tl_rchf_z01
Calibrated ensemble
Sampled prior
12%
10%
8%
6%
4%
2%
0%
0
10^{-3}
10^{-2}
10^{-1}
10^{0}
0


tl_ss_z01
Calibrated ensemble
Sampled prior
14%
12%
10%
8%
6%
4%
2%
0%
10^{-7}
10^{-6}
10^{-5}


tl_sy_z01
Calibrated ensemble
Sampled prior
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10%
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4%
2%
0%
0
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10^{-2}
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Appendix F Sensitivity Analysis Plots

Blackwater North Extension Project

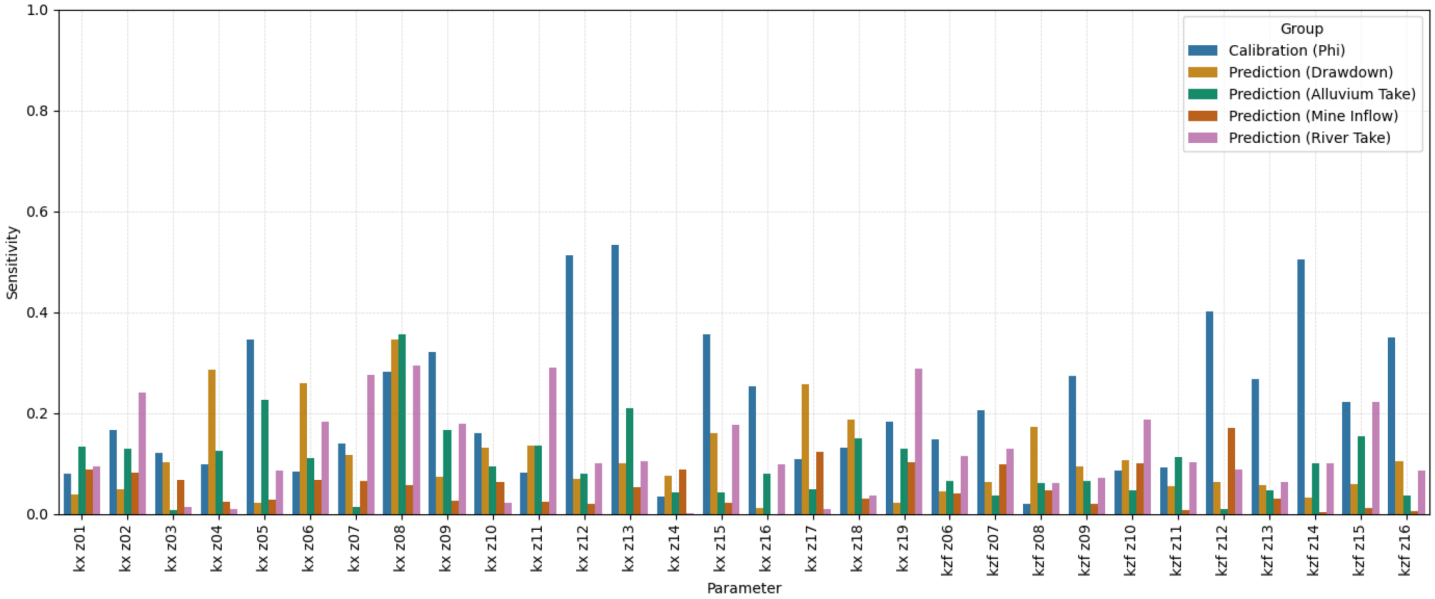
Groundwater Modelling Technical Report

Whitehaven Blackwater Pty Ltd

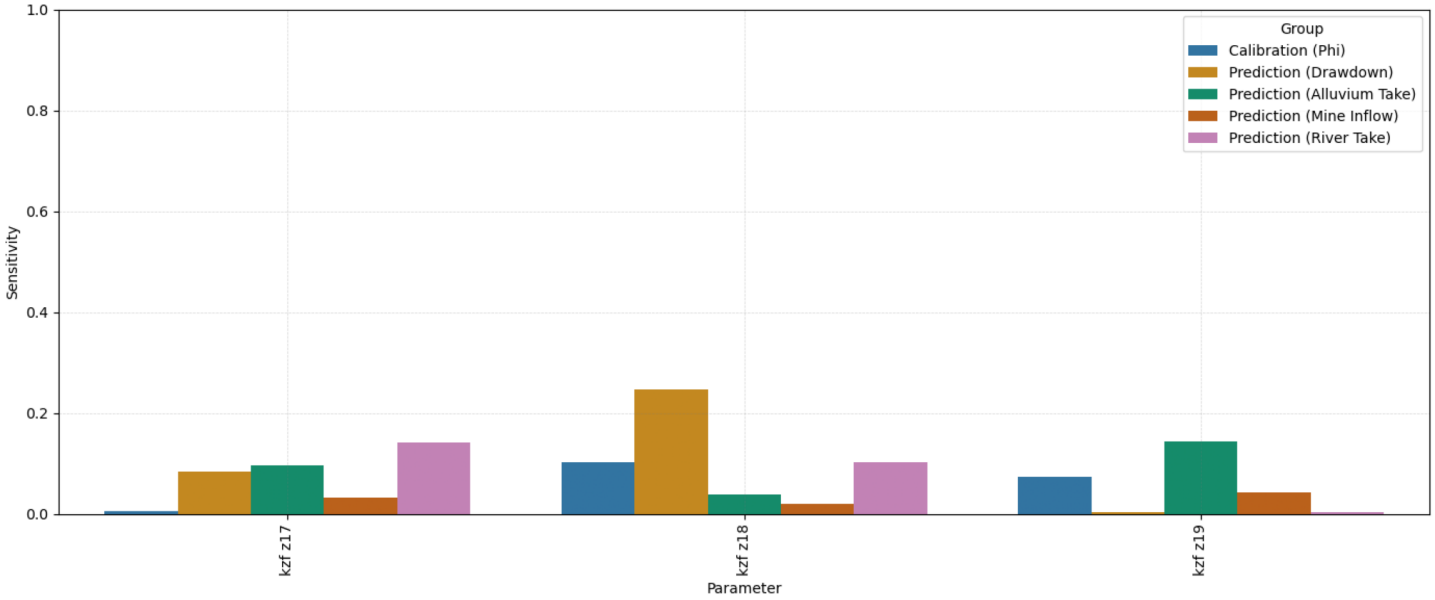
SLR Project No.: 640.031809.00001

7 October 2026

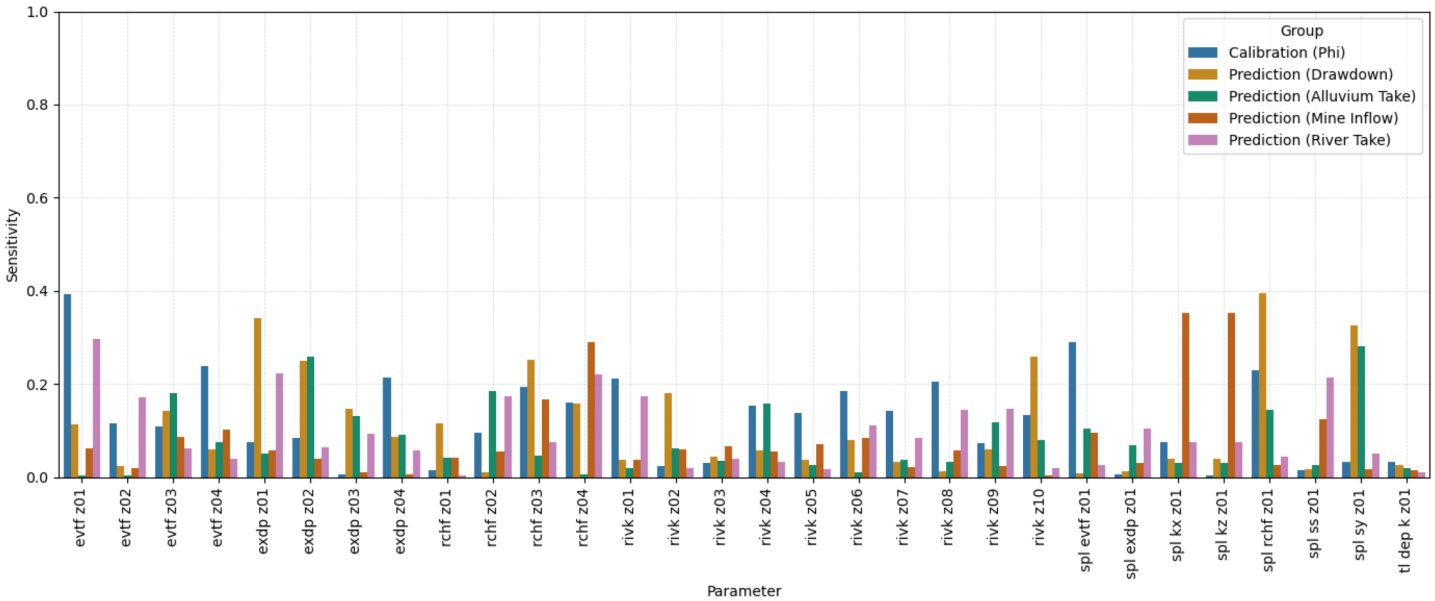
Linear Regression Sensitivity Coefficient (Absolute Value)_Hydraulic Conductivity_Figure1



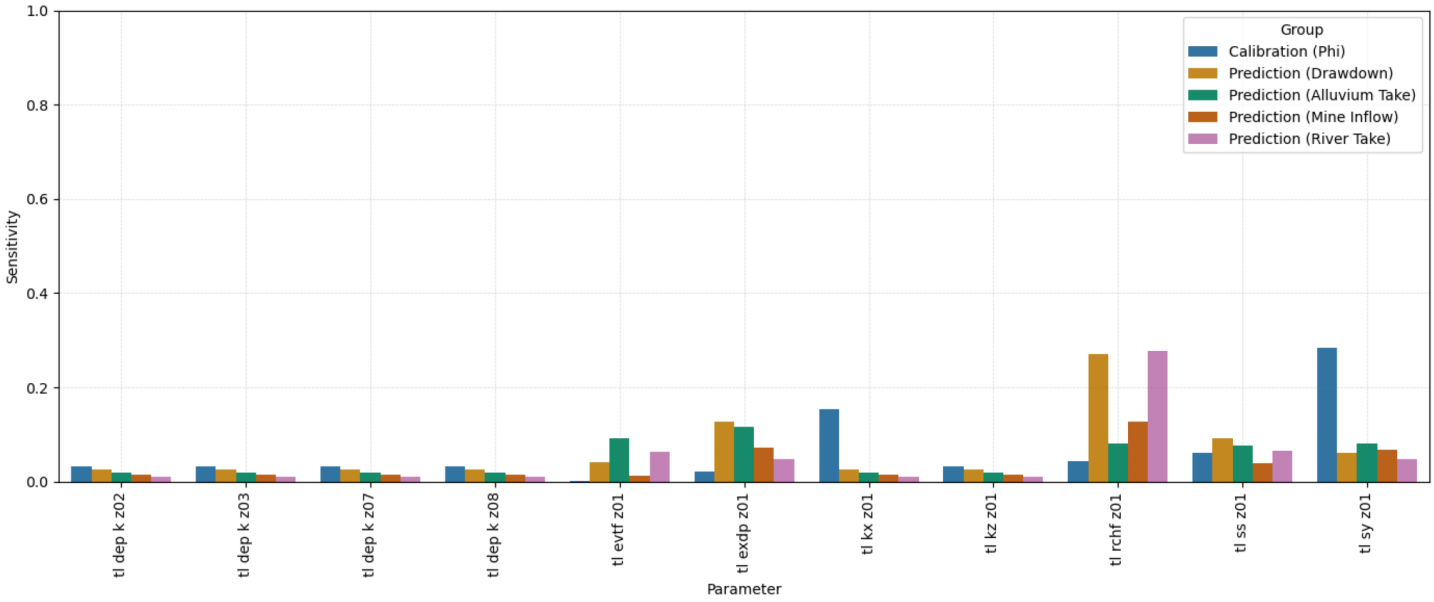
Linear Regression Sensitivity Coefficient (Absolute Value)_Hydraulic Conductivity_Figure2



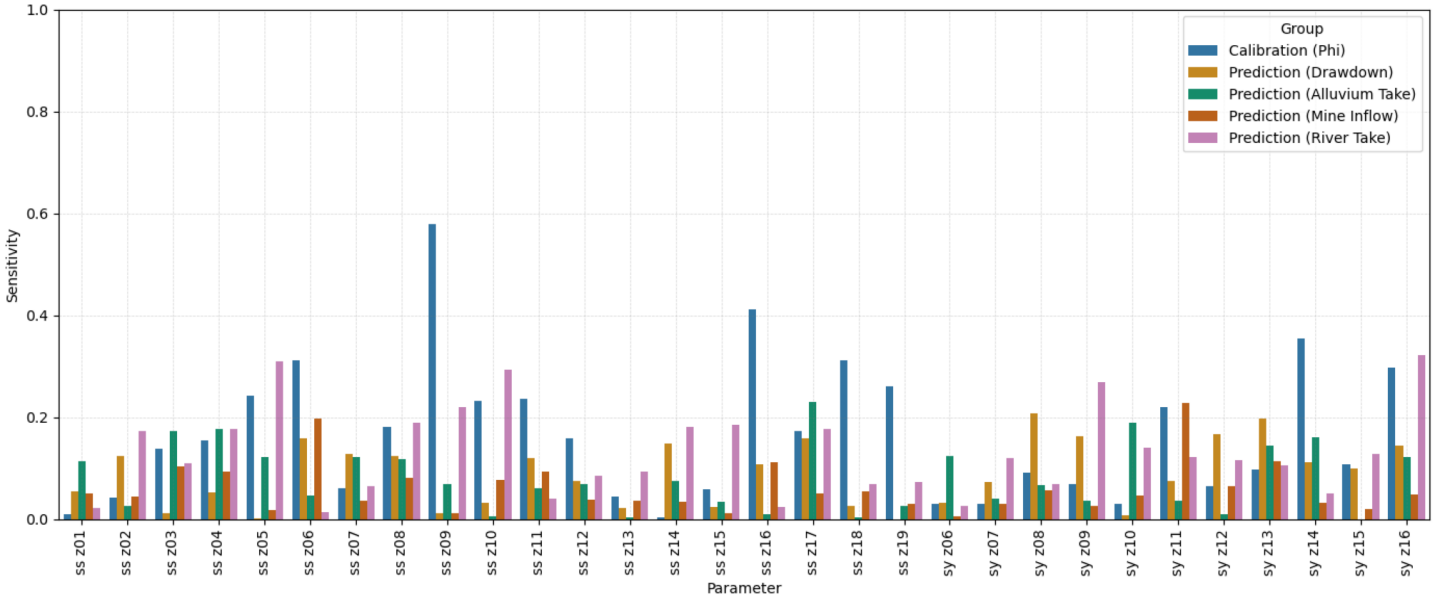
Linear Regression Sensitivity Coefficient (Absolute Value)_Boundary Conditions and Spoil_Figure1



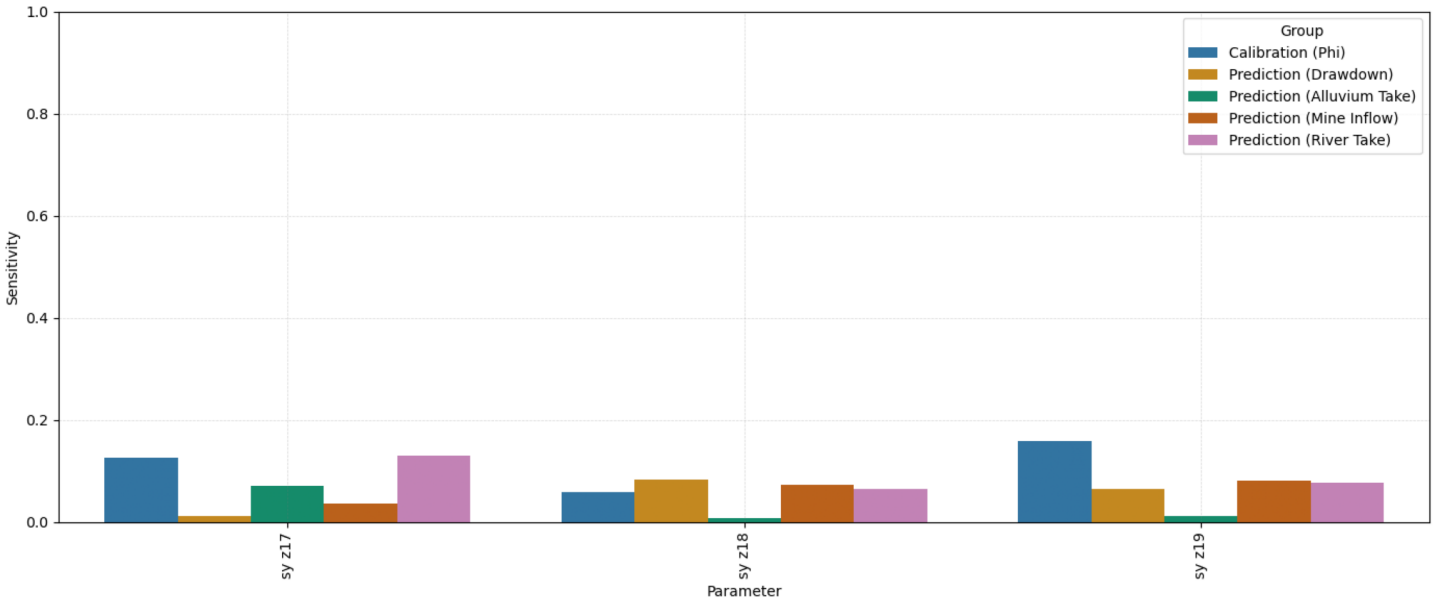
Linear Regression Sensitivity Coefficient (Absolute Value)_Boundary Conditions and Spoil_Figure2



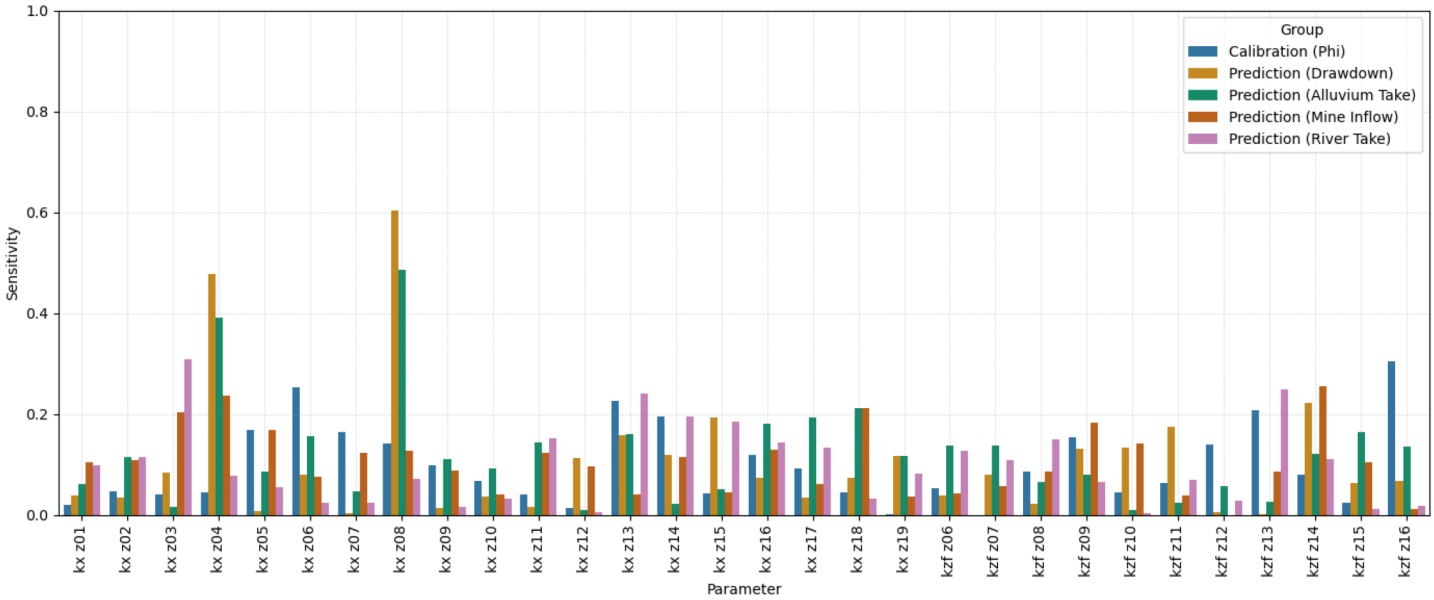
Linear Regression Sensitivity Coefficient (Absolute Value)_Storage Parameters_Figure1



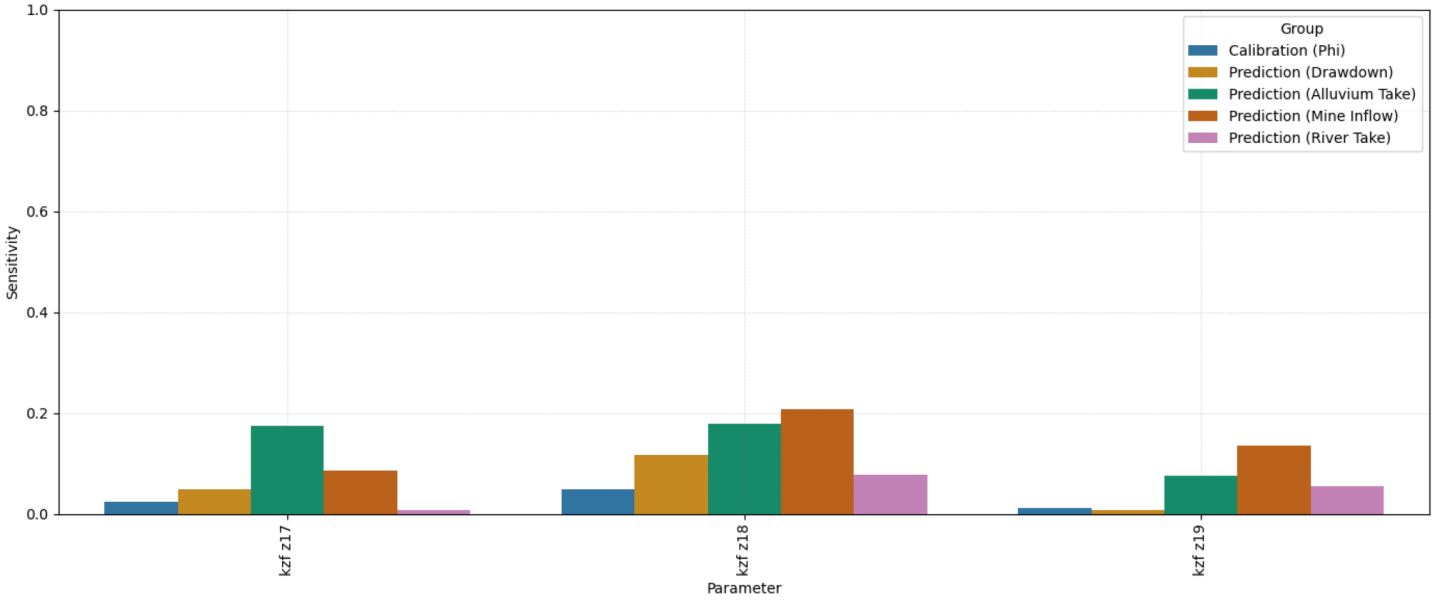
Linear Regression Sensitivity Coefficient (Absolute Value)_Storage Parameters_Figure2



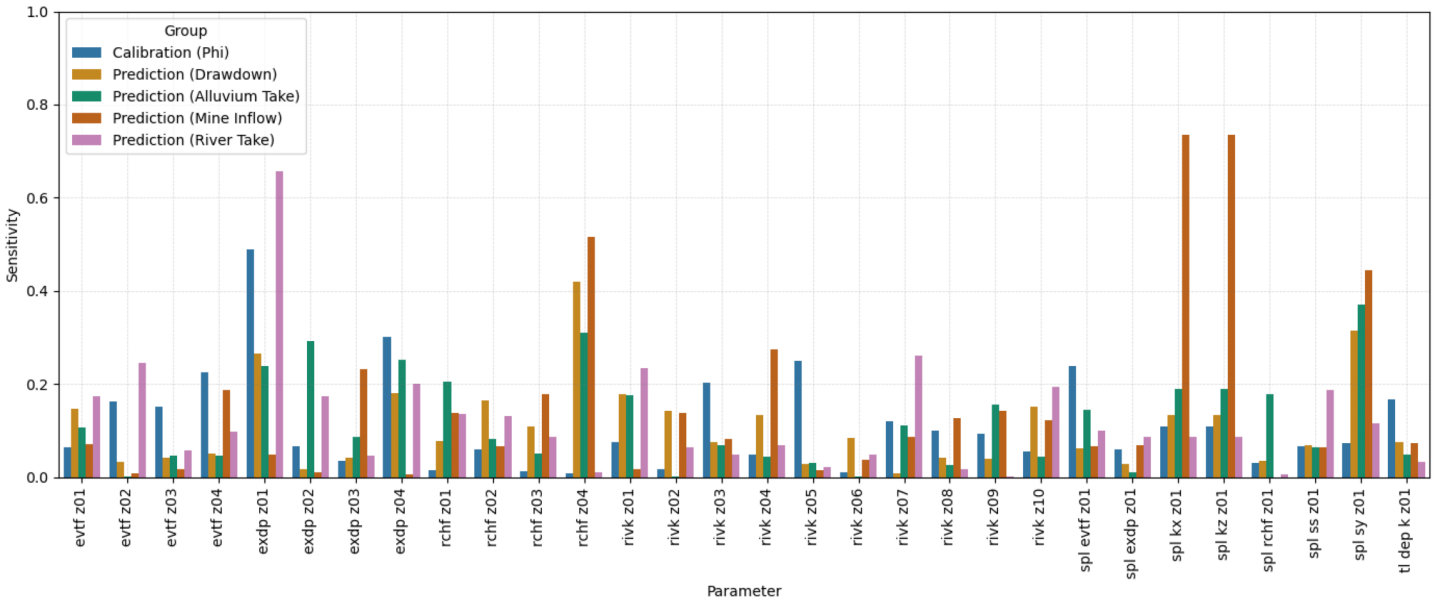
Spearman Rank Correlation Coefficient (Absolute Value)_Hydraulic Conductivity_Figure1



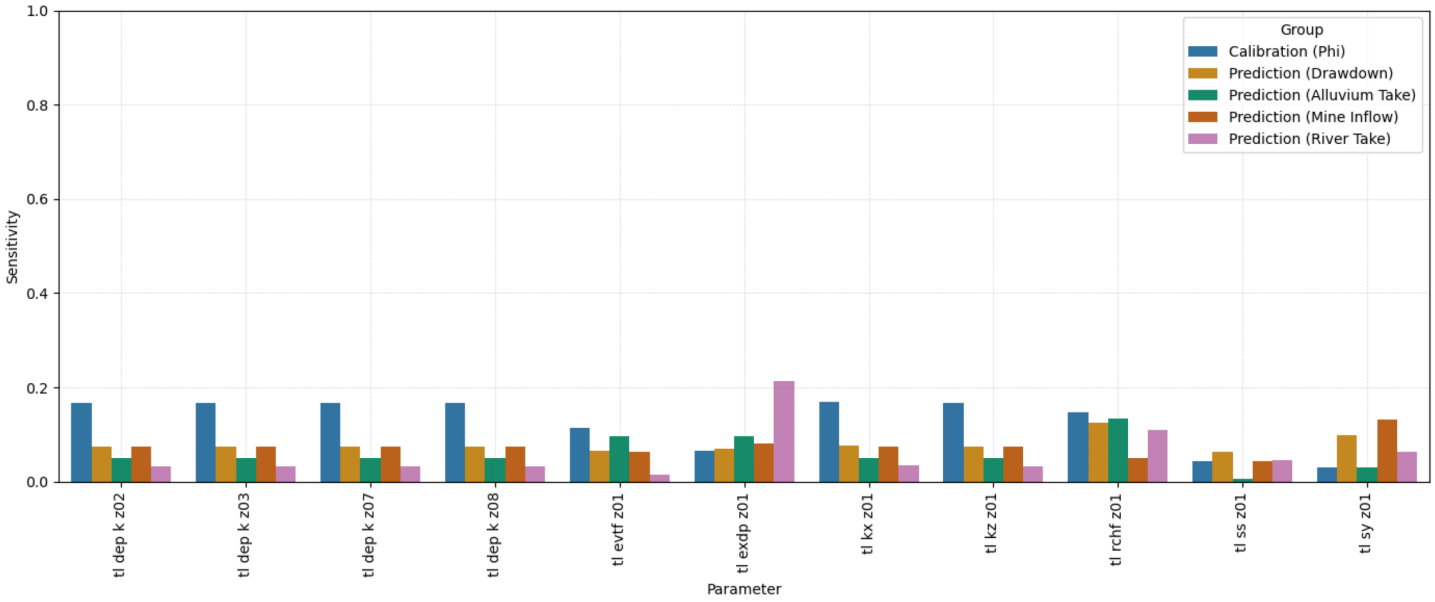
Spearman Rank Correlation Coefficient (Absolute Value)_Hydraulic Conductivity_Figure2



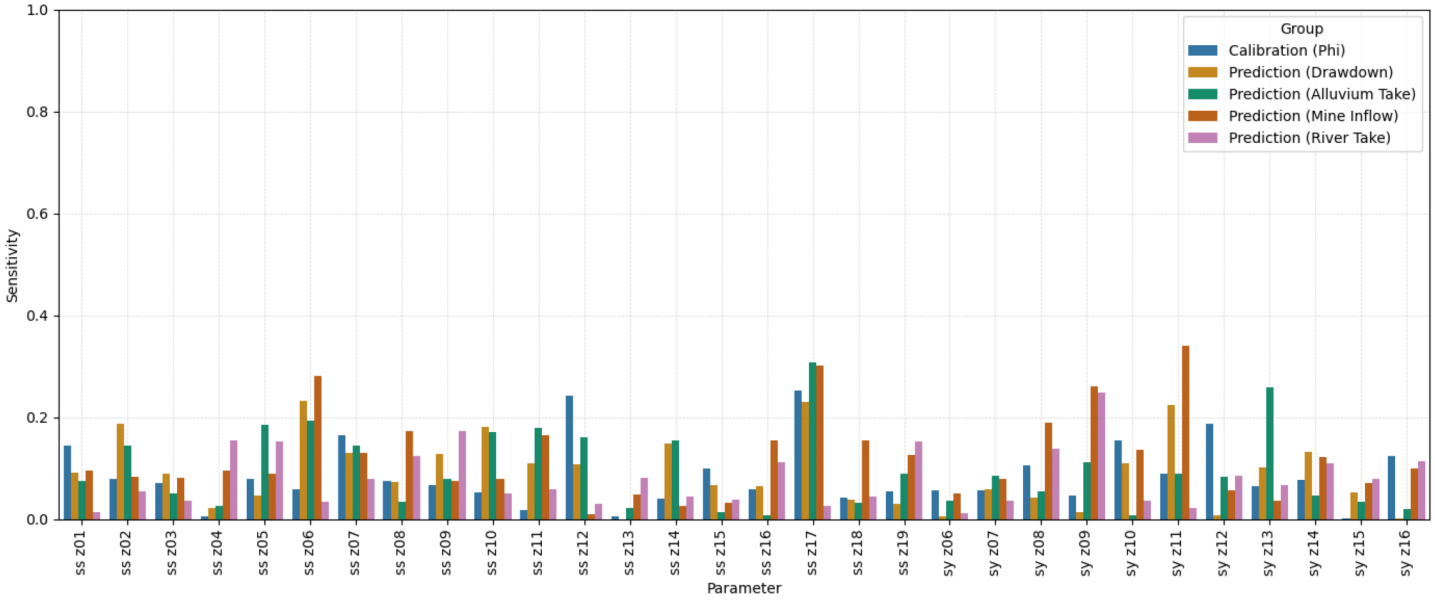
Spearman Rank Correlation Coefficient (Absolute Value)_Boundary Conditions and Spoil_Figure1



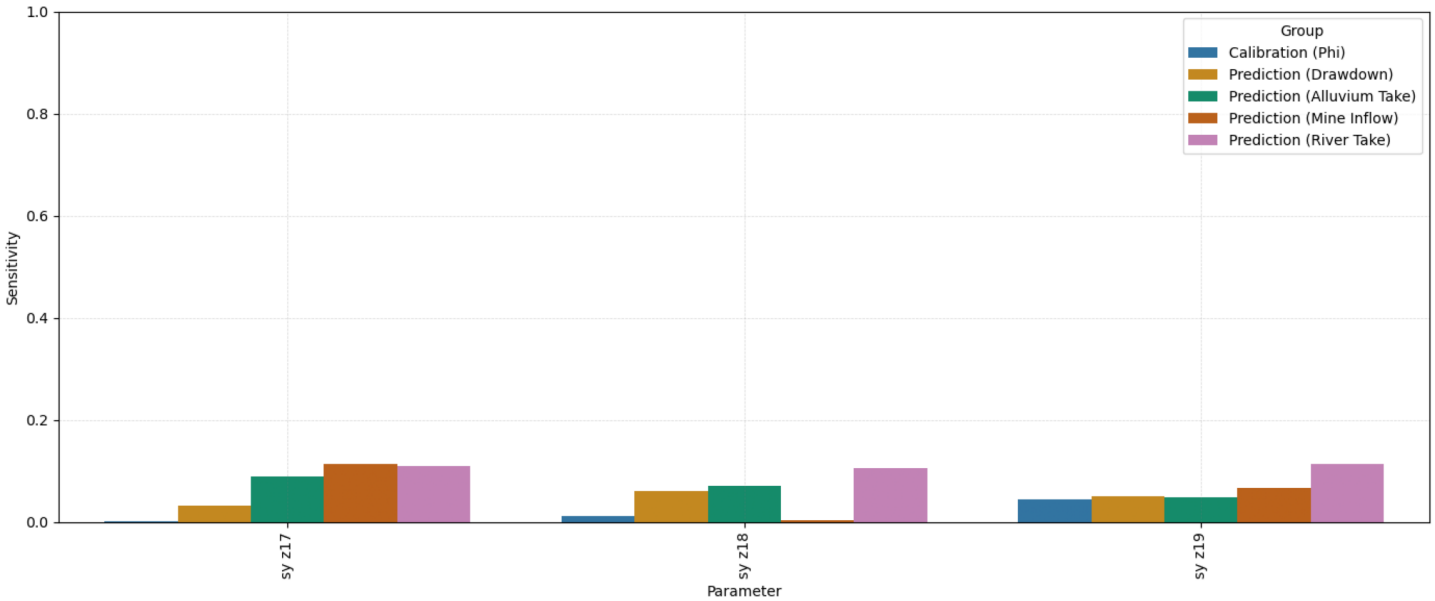
Spearman Rank Correlation Coefficient (Absolute Value)_Boundary Conditions and Spoil_Figure2



Spearman Rank Correlation Coefficient (Absolute Value)_Storage Parameters_Figure1



Spearman Rank Correlation Coefficient (Absolute Value)_Storage Parameters_Figure2



Appendix G Uncertainty in 1 m Drawdown Contours

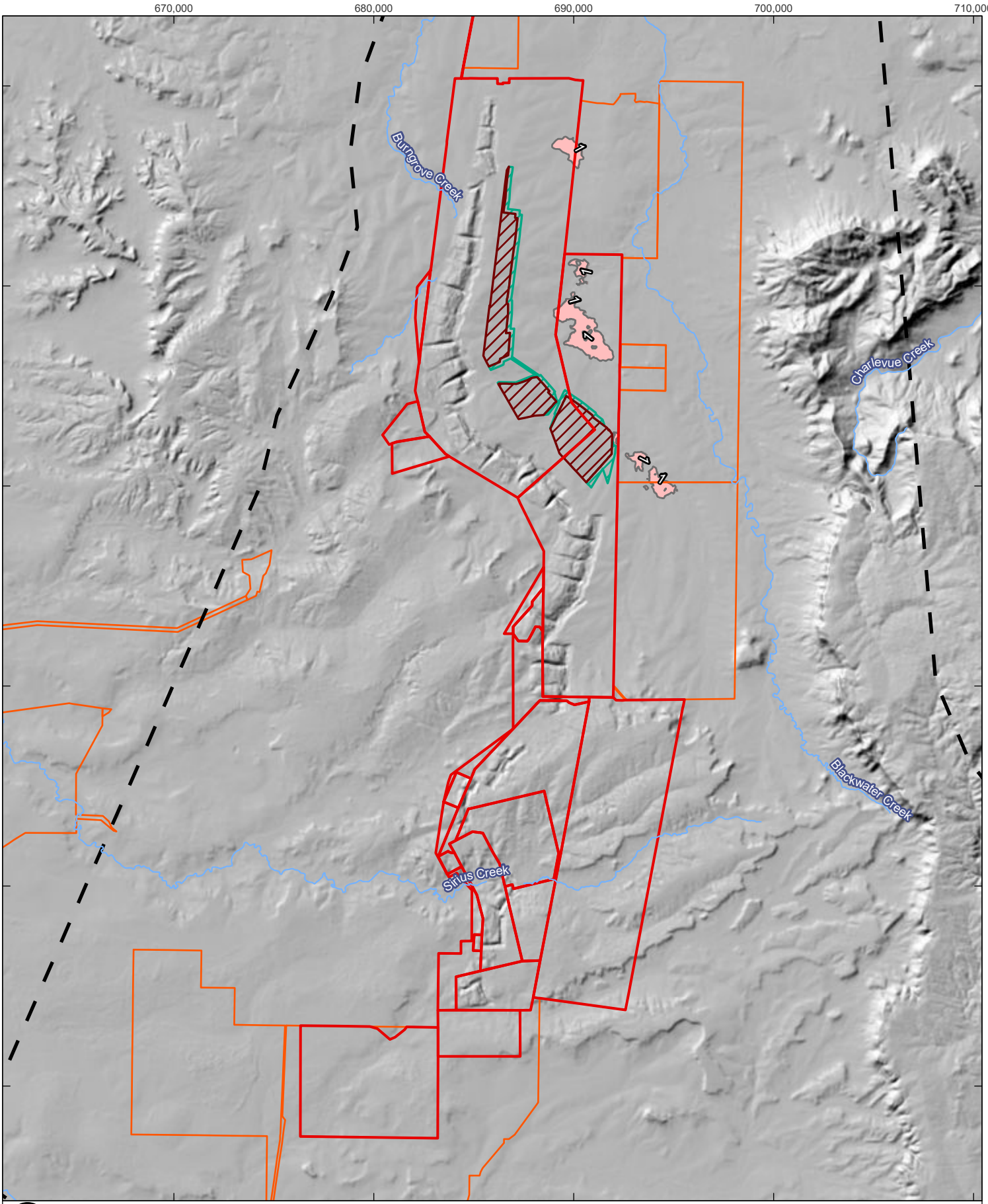
Blackwater North Extension Project

Groundwater Modelling Technical Report

Whitehaven Blackwater Pty Ltd

SLR Project No.: 640.031809.00001

7 October 2026



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	08-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

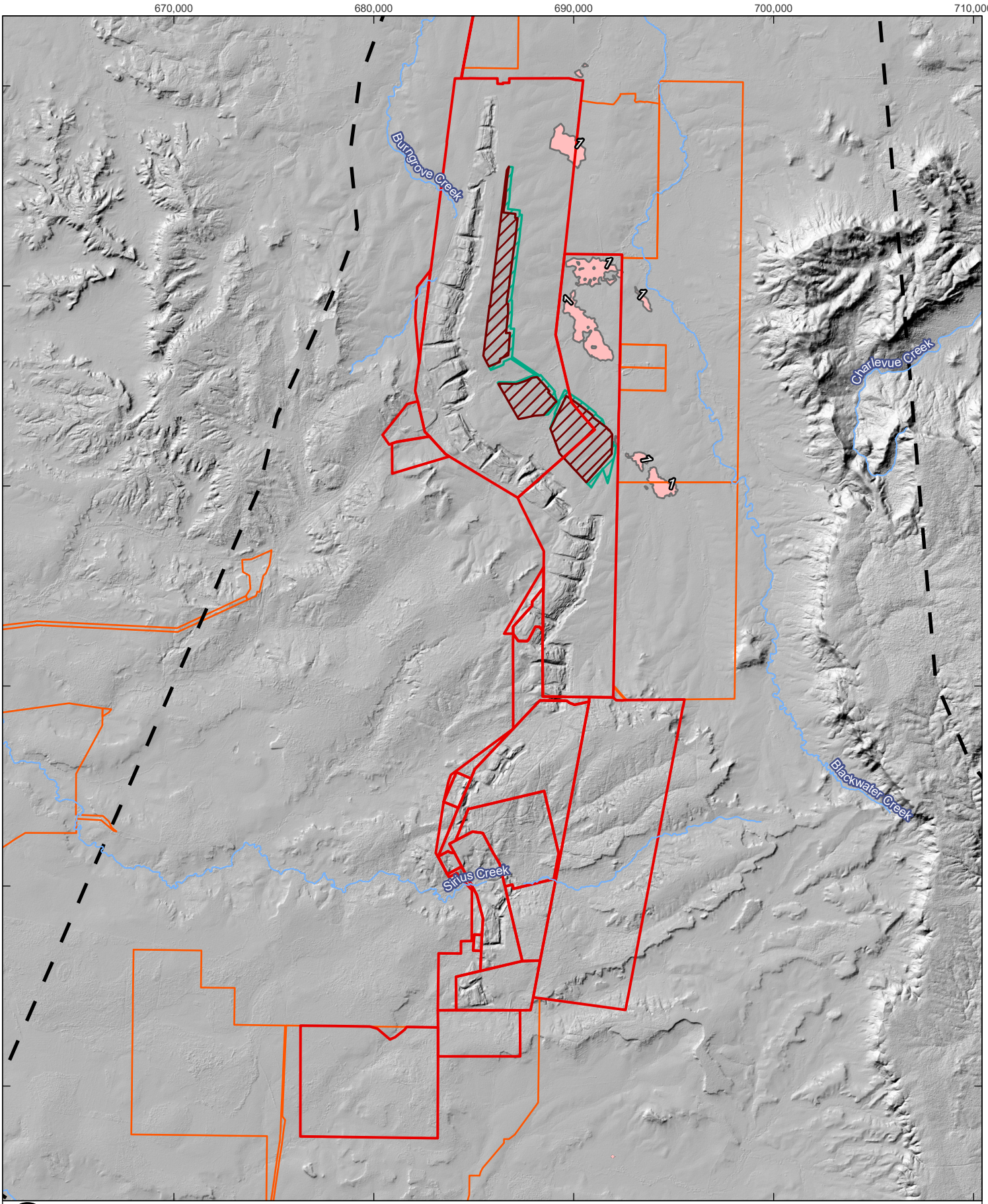
UNCERTAINTY IN PREDICTED 1M INCREMENTAL DRAWDOWN IN ALLUVIUM/TERTIARY (END OF MINING) (LAYER 1)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-1

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E01_Uncertainty in Predicted 1m Incremental DD in Alluvium and Tertiary (EoM) L1



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

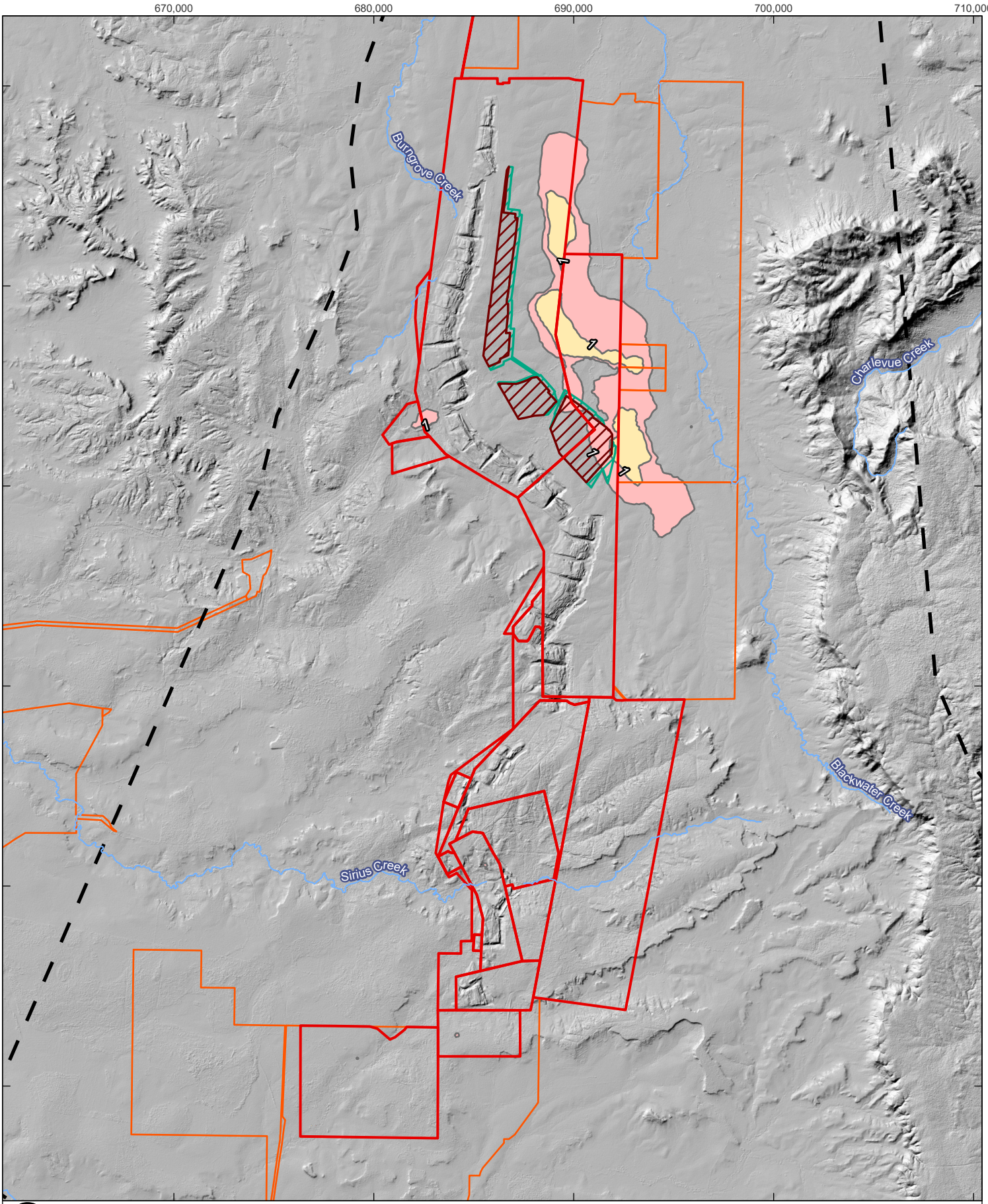
UNCERTAINTY IN PREDICTED 1M INCREMENTAL DRAWDOWN IN ALLUVIUM/TERTIARY (END OF RECOVERY) (LAYER 1)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-2

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E02_Uncertainty in Predicted 1m Incremental DD in Alluvium and Tertiary (EoR) L1



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

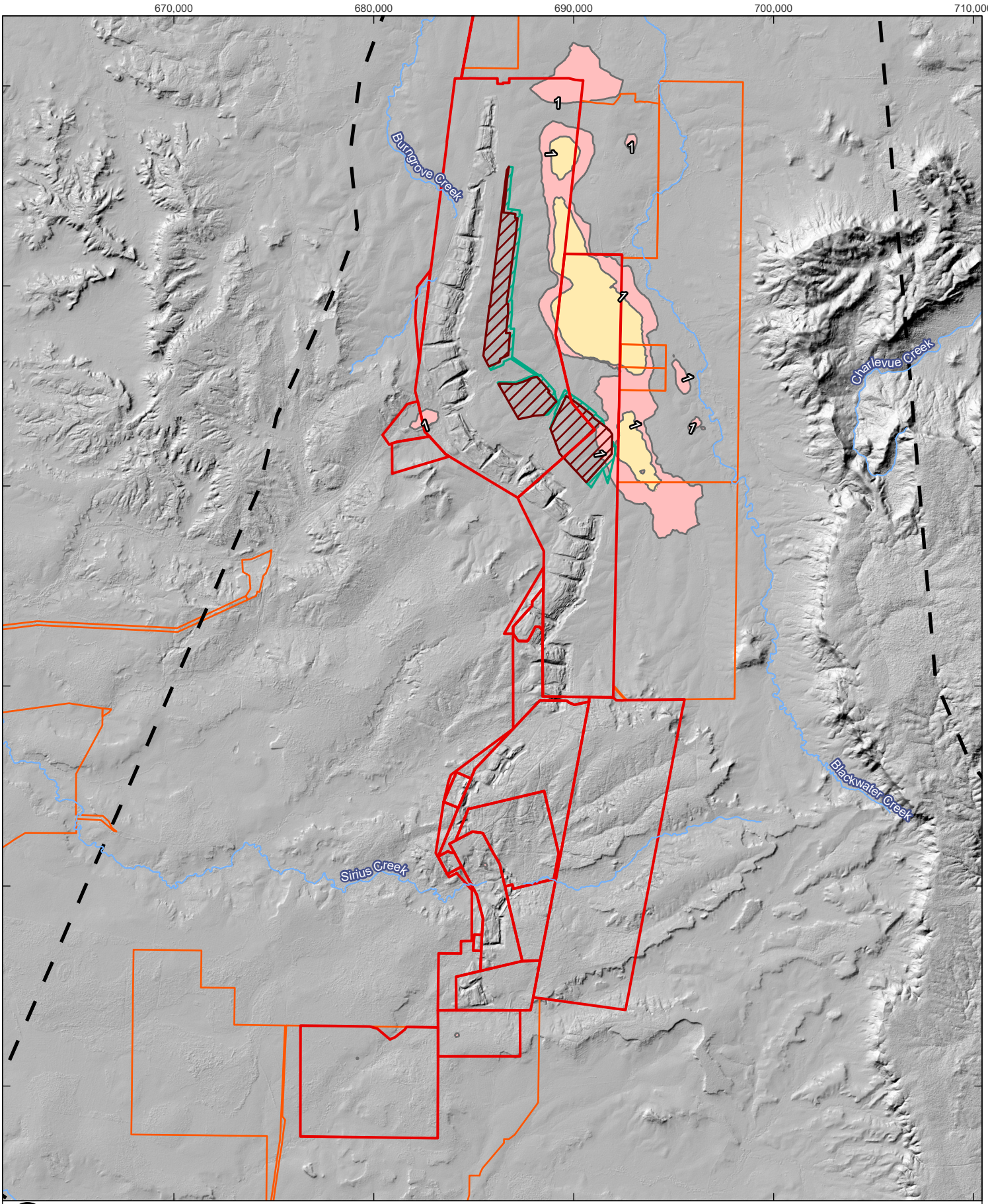
UNCERTAINTY IN PREDICTED 1M INCREMENTAL DRAWDOWN IN ALLUVIUM/WEATHERED (END OF MINING) (LAYER 2)

SLR

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APPENDIX G-3

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E03_Uncertainty in Predicted 1m Incremental DD in Alluvium and Weathered (EoM) L2



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

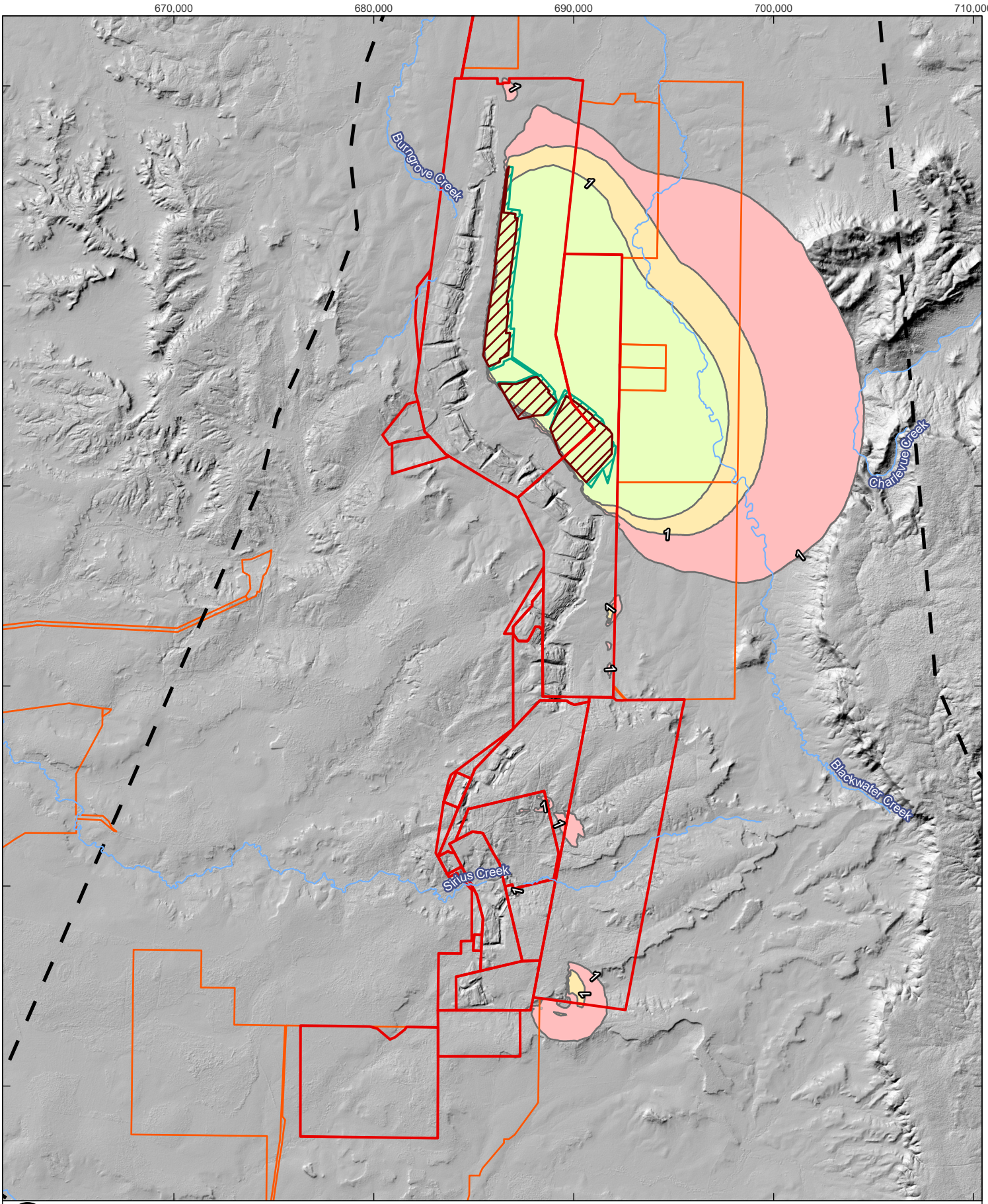
UNCERTAINTY IN PREDICTED 1M INCREMENTAL DRAWDOWN IN ALLUVIUM/WEATHERED (END OF RECOVERY) (LAYER 2)

SLR

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APPENDIX G-4

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E04_Uncertainty in Predicted 1m Incremental DD in Alluvium and Weathered (EoR) L2



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

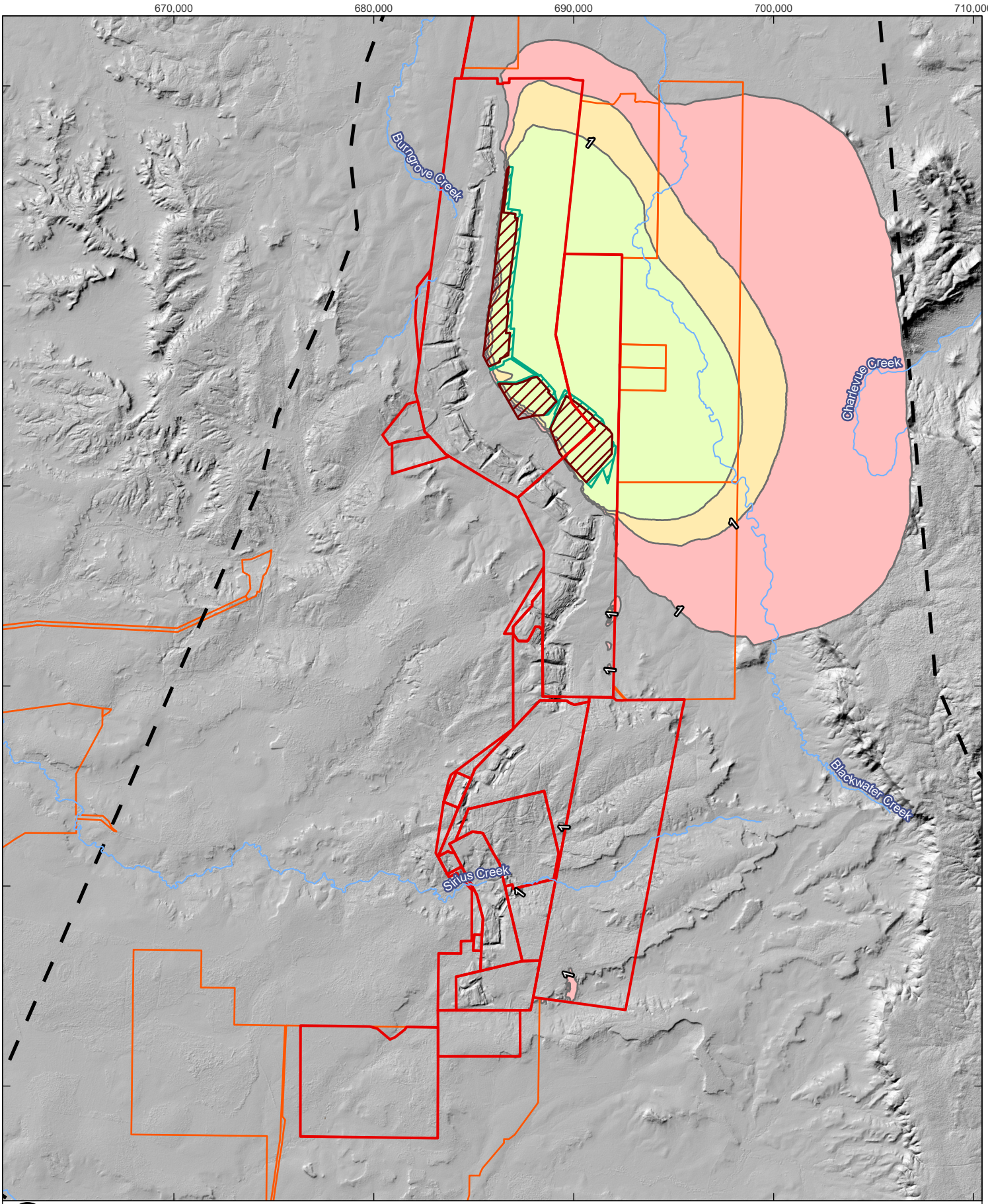
UNCERTAINTY IN PREDICTED 1M INCREMENTAL DRAWDOWN IN ARIES SEAM (END OF MINING) (LAYER 8)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-5

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E05_Uncertainty in Predicted 1m Incremental DD in Aries Seam (EoM) L8



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

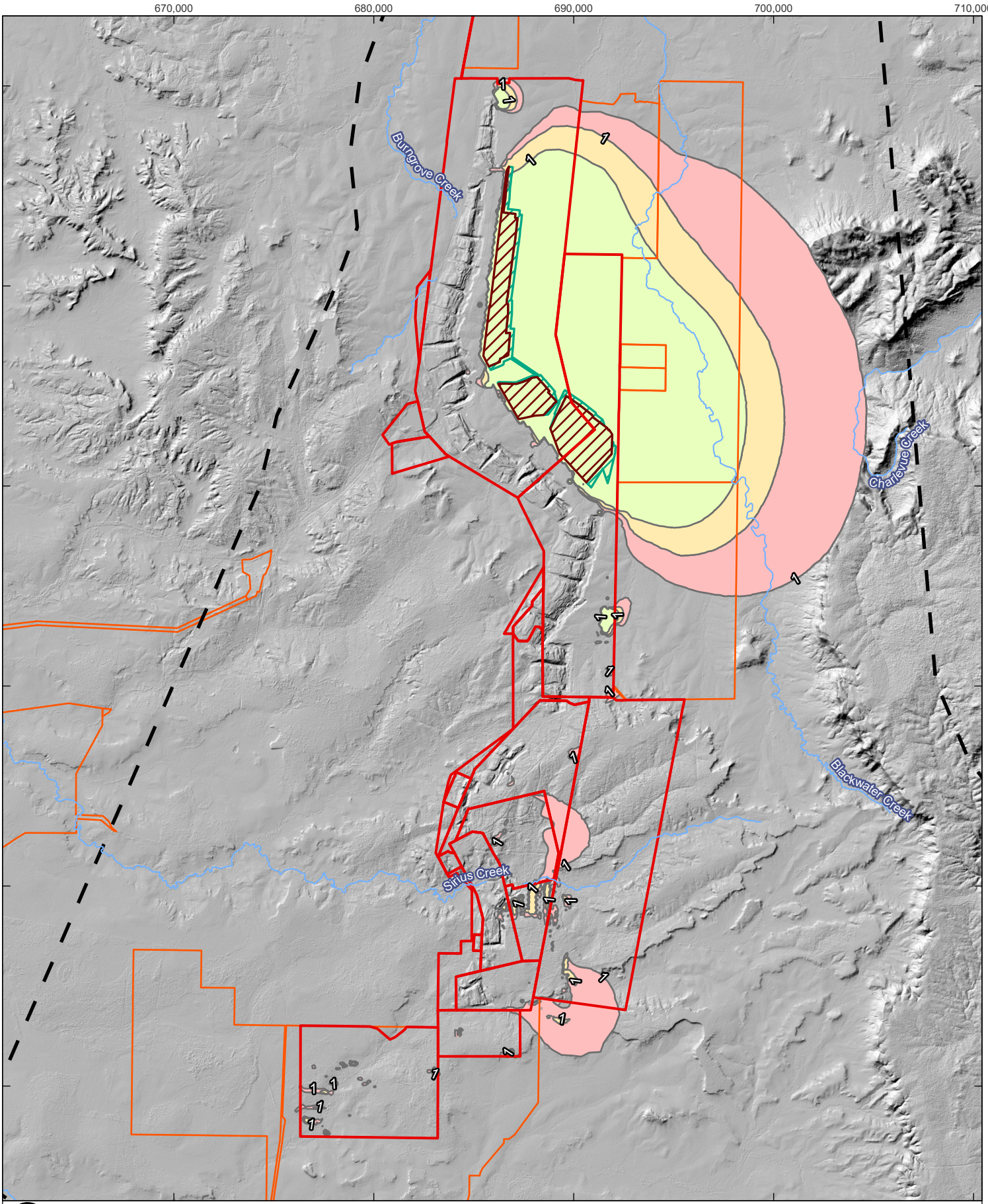
UNCERTAINTY IN PREDICTED 1M INCREMENTAL DRAWDOWN IN ARIES SEAM (END OF RECOVERY) (LAYER 8)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-6

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E06_Uncertainty in Predicted 1m Incremental DD in Aries Seam (EoR) L8



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

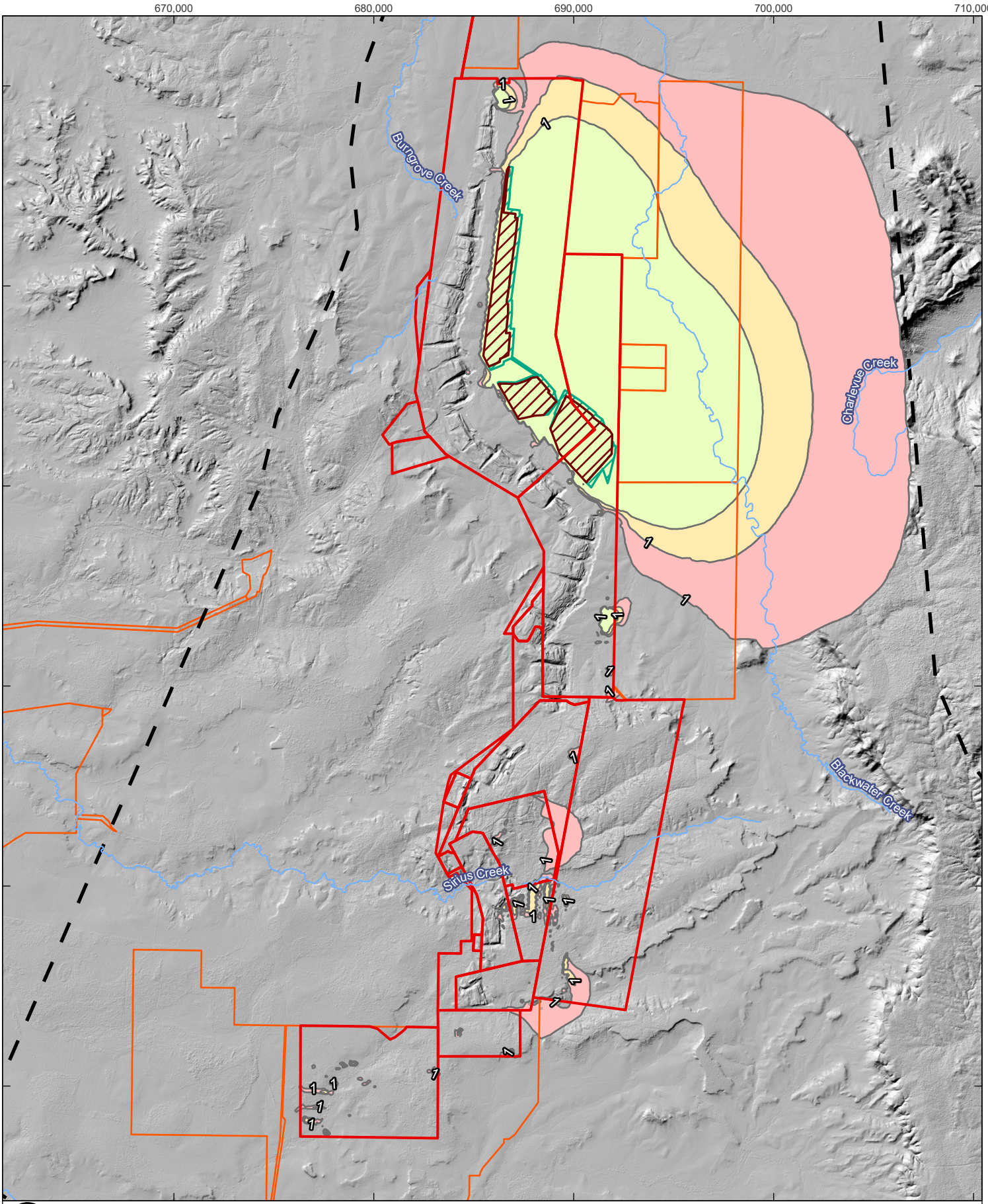
UNCERTAINTY IN PREDICTED 1M INCREMENTAL DRAWDOWN IN POLLUX SEAM (END OF MINING) (LAYER 12)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-7

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E07_Uncertainty in Predicted 1m Incremental DD in Pollux Seam (EoM) L12



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

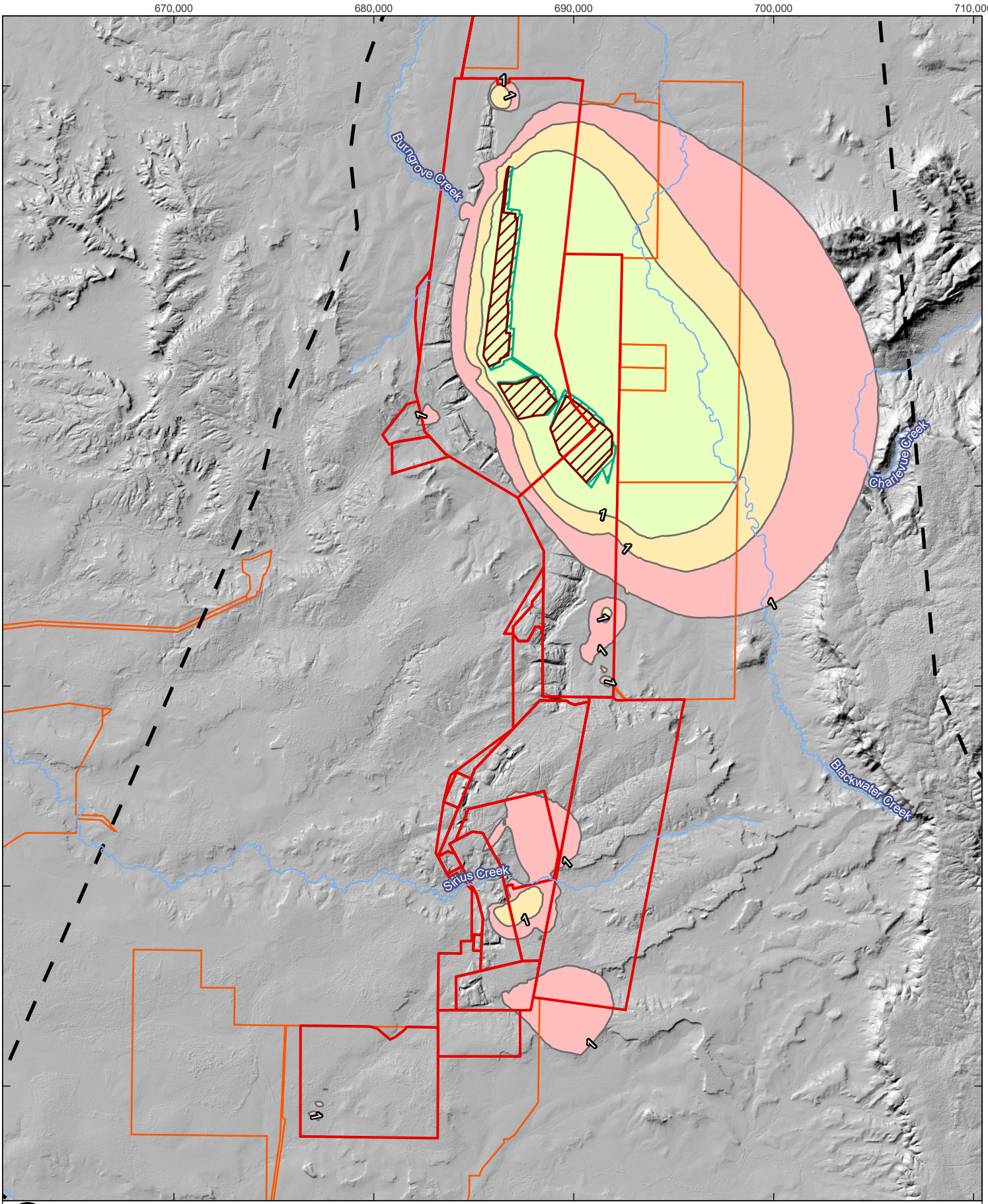
UNCERTAINTY IN PREDICTED 1M INCREMENTAL DRAWDOWN IN POLLUX SEAM (END OF RECOVERY) (LAYER 12)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-8

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E08_Uncertainty in Predicted 1m Incremental DD in Pollux Seam (EoR) L12



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

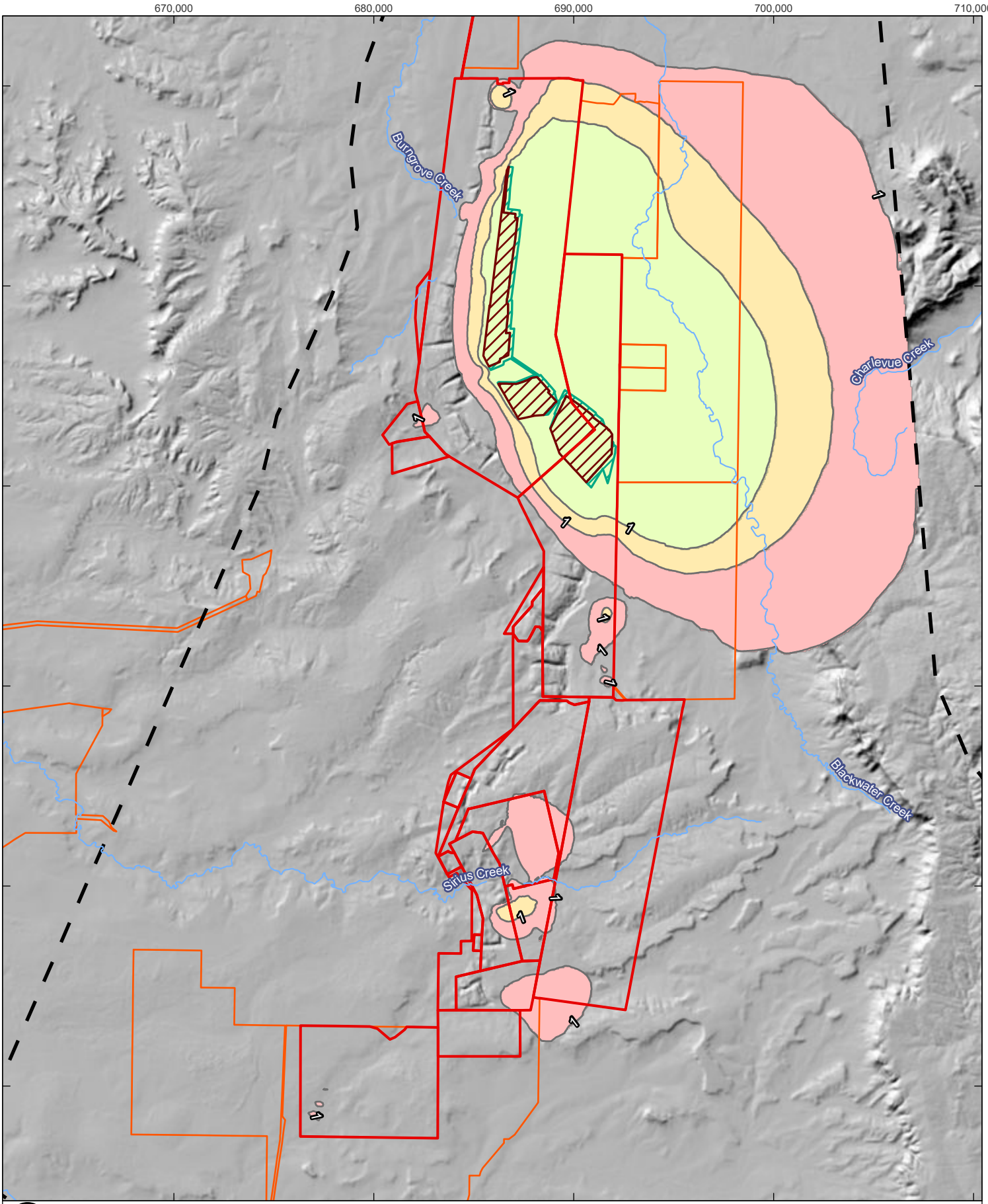
UNCERTAINTY IN PREDICTED 1M INCREMENTAL DRAWDOWN IN BURNGROVE FORMATION (END OF MINING) (LAYER 16)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-9

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E09_Uncertainty in Predicted 1m Incremental DD in Burngrove Formation (EoM) L16



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	08-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

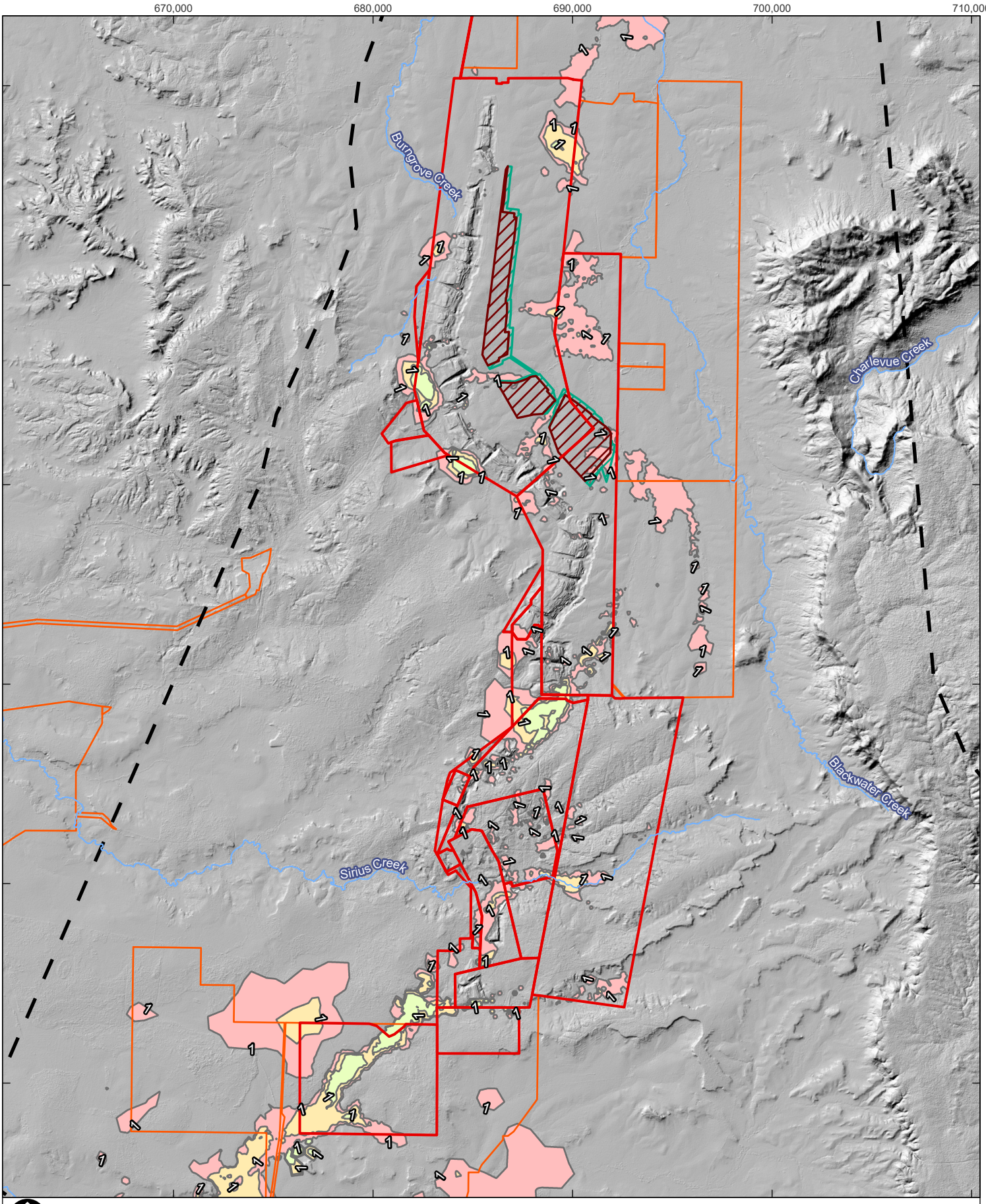
UNCERTAINTY IN PREDICTED 1M INCREMENTAL DRAWDOWN IN BURNGROVE FORMATION (END OF RECOVERY) (LAYER 16)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-10

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E10_Uncertainty in Predicted 1m Incremental DD in Burngrove Formation (EoR) L16



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

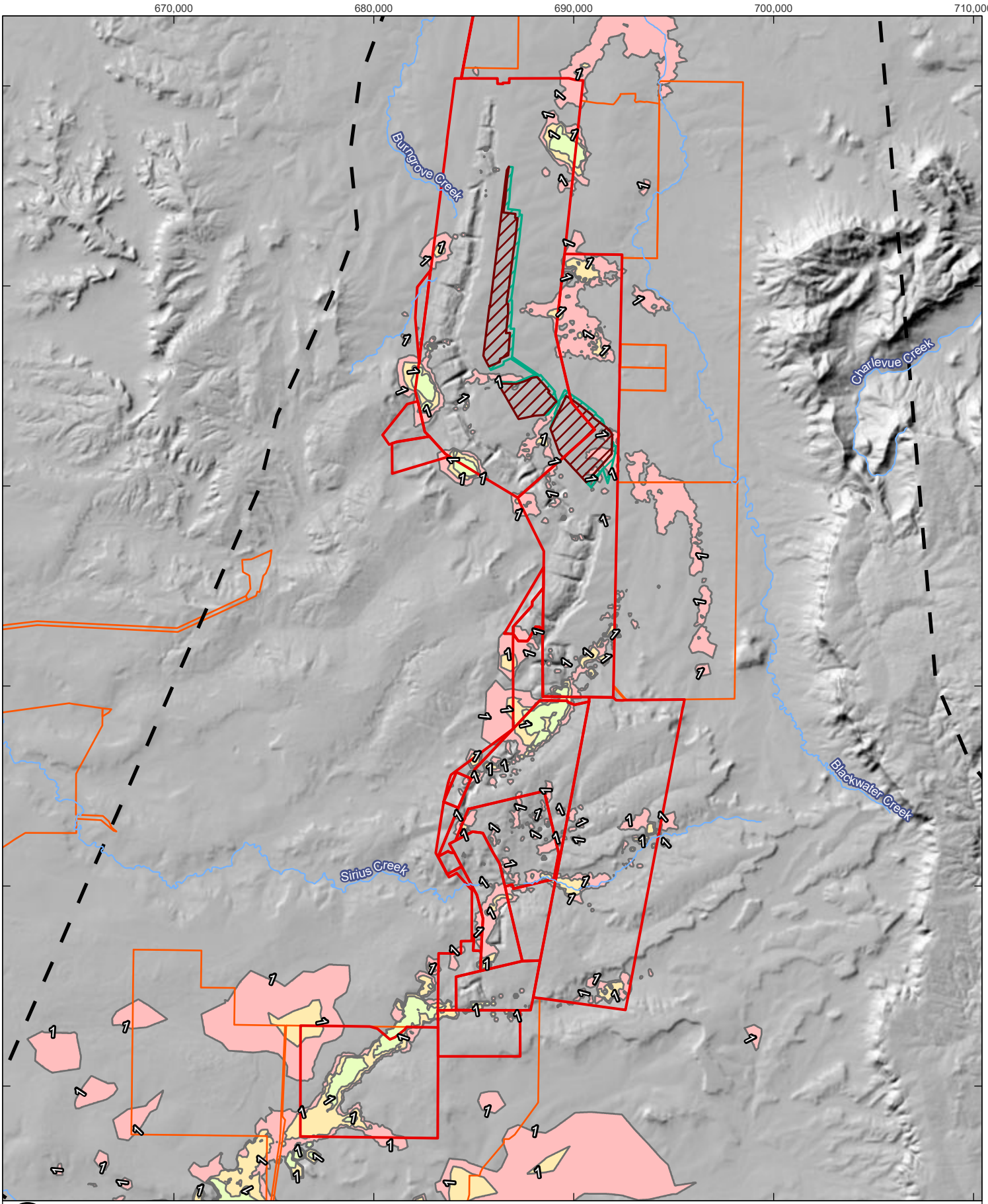
UNCERTAINTY IN PREDICTED 1M CUMULATIVE DRAWDOWN IN ALLUVIUM/TERTIARY (END OF MINING) (LAYER 1)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-11

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E11_Uncertainty in Predicted 1m Cumulative DD in Alluvium and Tertiary (EoM) L1



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	08-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

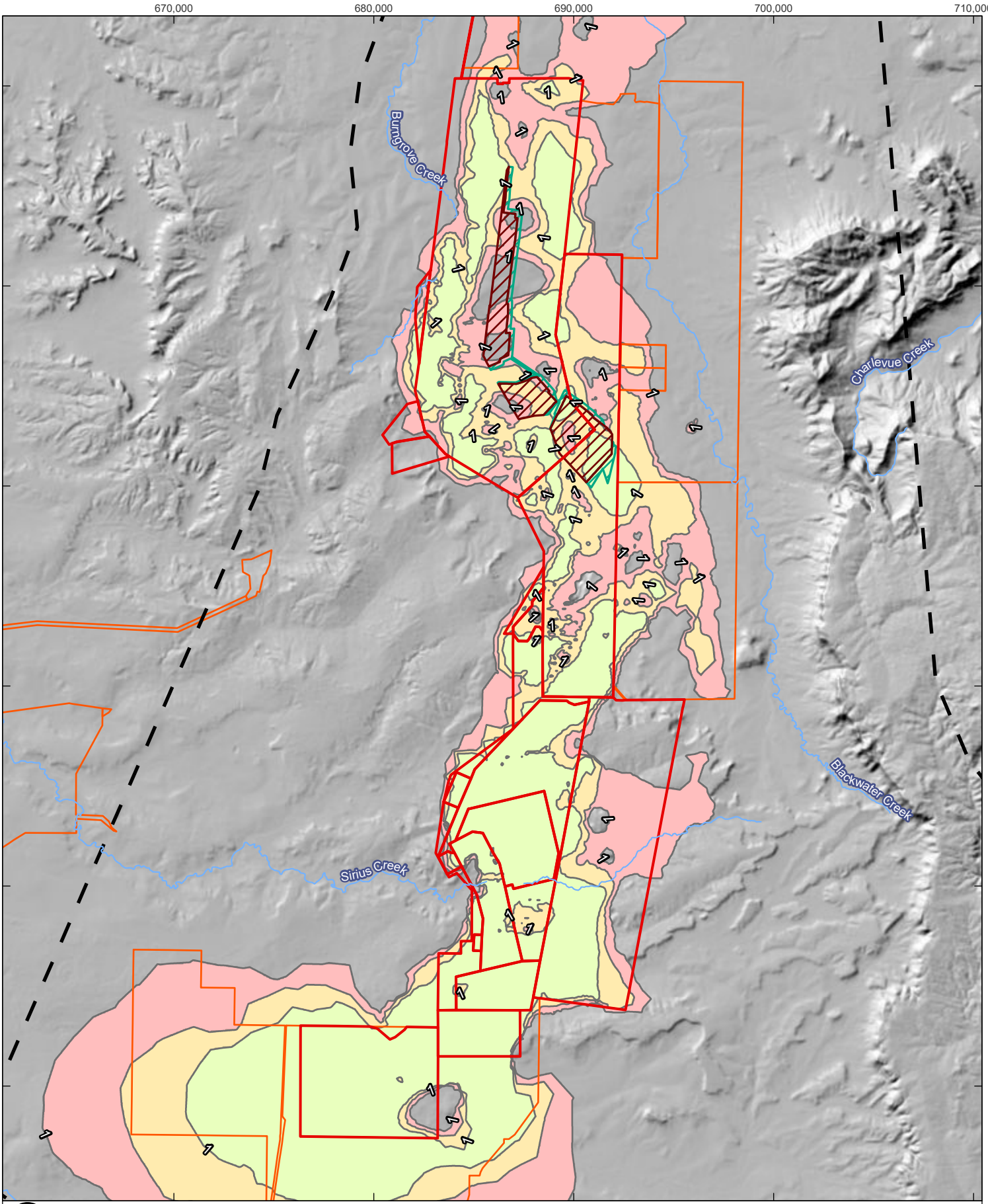
UNCERTAINTY IN PREDICTED 1M CUMULATIVE DRAWDOWN IN ALLUVIUM/TERTIARY (END OF RECOVERY) (LAYER 1)

SLR

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APPENDIX G-12

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E12_Uncertainty in Predicted 1m Cumulative DD in Alluvium and Tertiary (EoR) L1



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	08-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

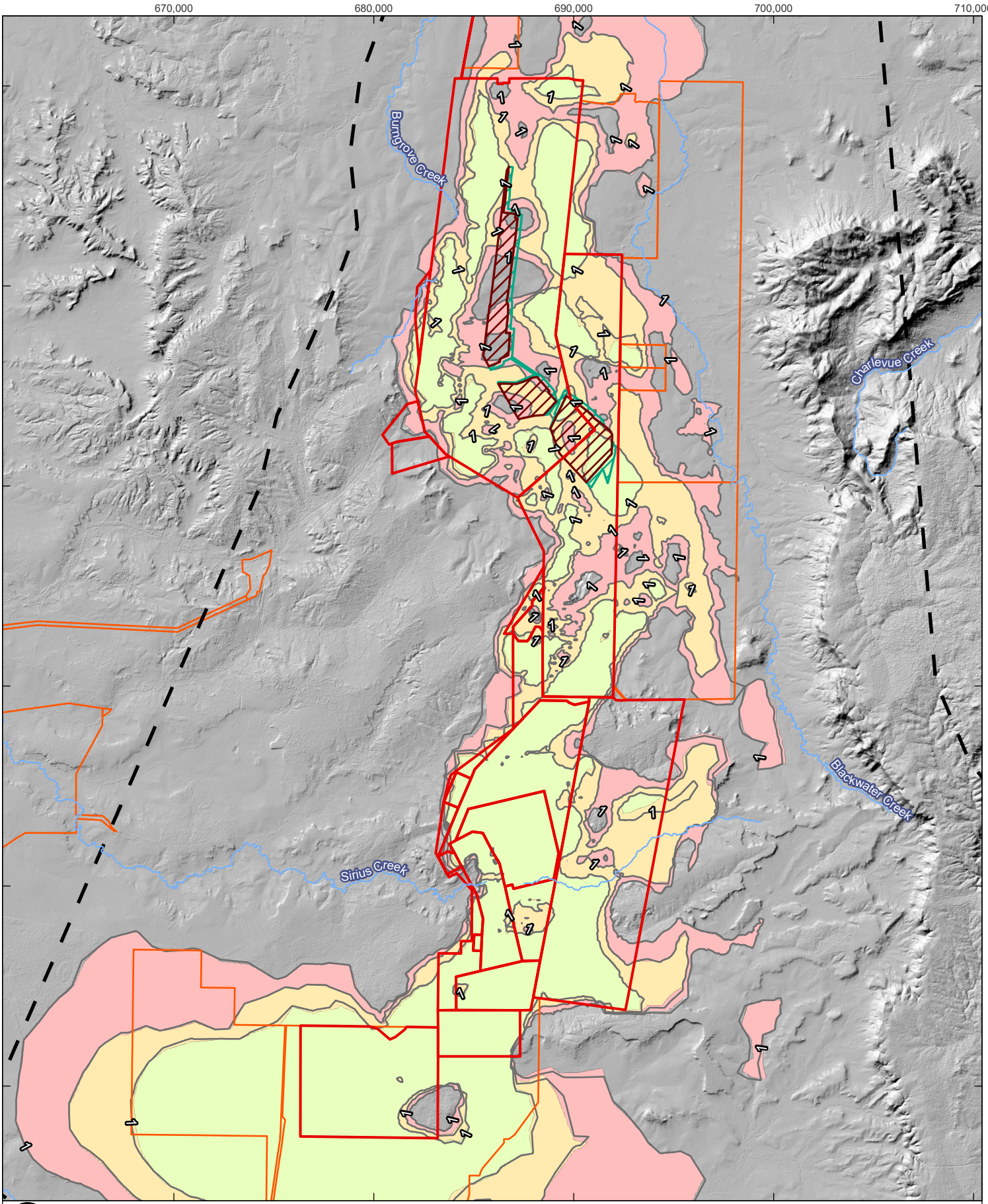
UNCERTAINTY IN PREDICTED 1M CUMULATIVE DRAWDOWN IN ALLUVIUM/WEATHERED (END OF MINING) (LAYER 2)

SLR

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APPENDIX G-13

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E13_Uncertainty in Predicted 1m Cumulative DD in Alluvium and Weathered (EoM) L2



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

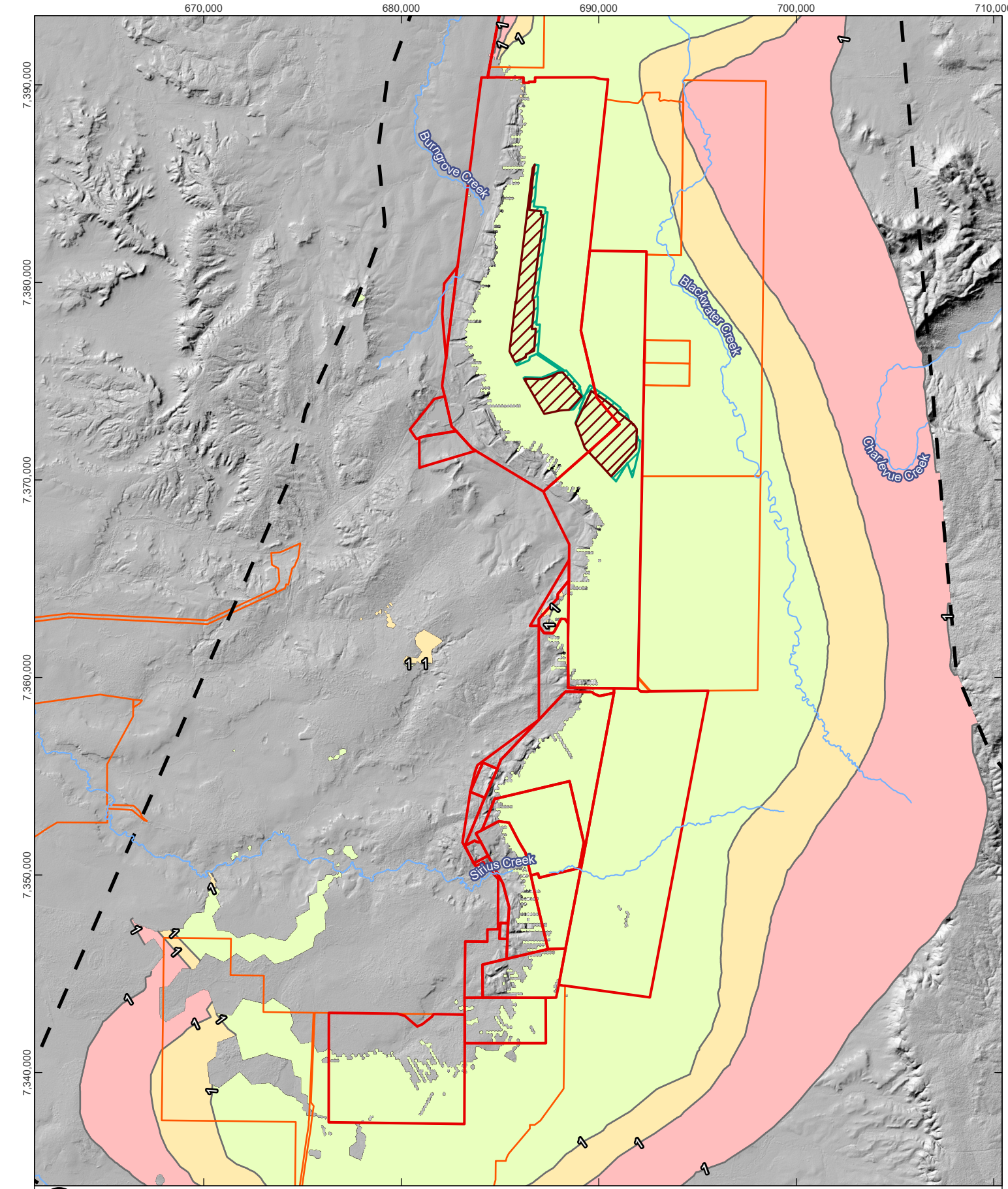
UNCERTAINTY IN PREDICTED 1M CUMULATIVE DRAWDOWN IN ALLUVIUM/WEATHERED (END OF RECOVERY) (LAYER 2)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-14

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E14_Uncertainty in Predicted 1m Cumulative DD in Alluvium and Weathered (EoR) L2



BLACKWATER NORTH EXTENSION PROJECT
GROUNDWATER MODELLING TECHNICAL REPORT

UNCERTAINTY IN PREDICTED 1M CUMULATIVE DRAWDOWN IN ARIES SEAM (END OF MINING) (LAYER 8)

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

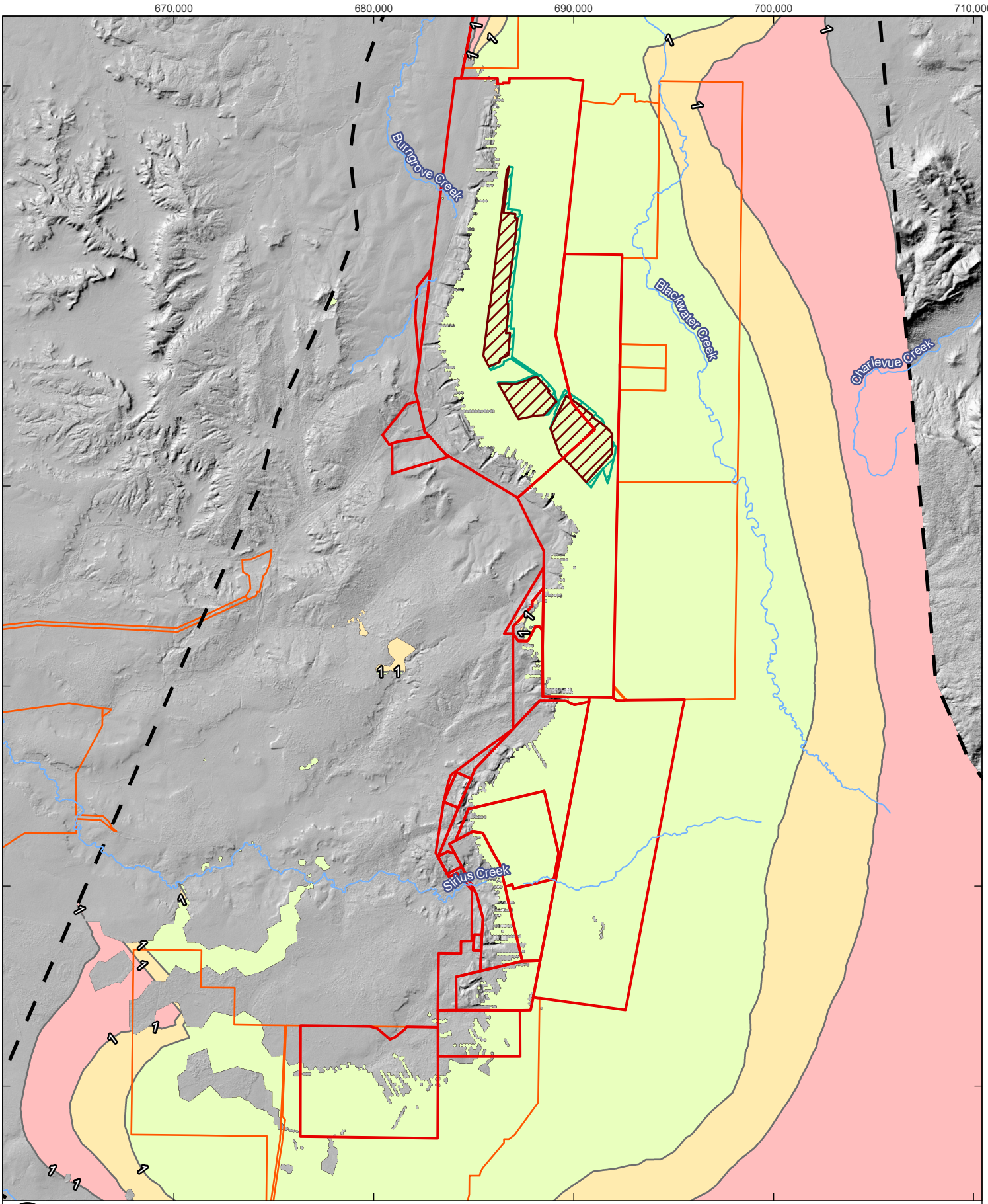
Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-15

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E15_Uncertainty in Predicted 1m Cumulative DD in Aries Seam (EoM) L8



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

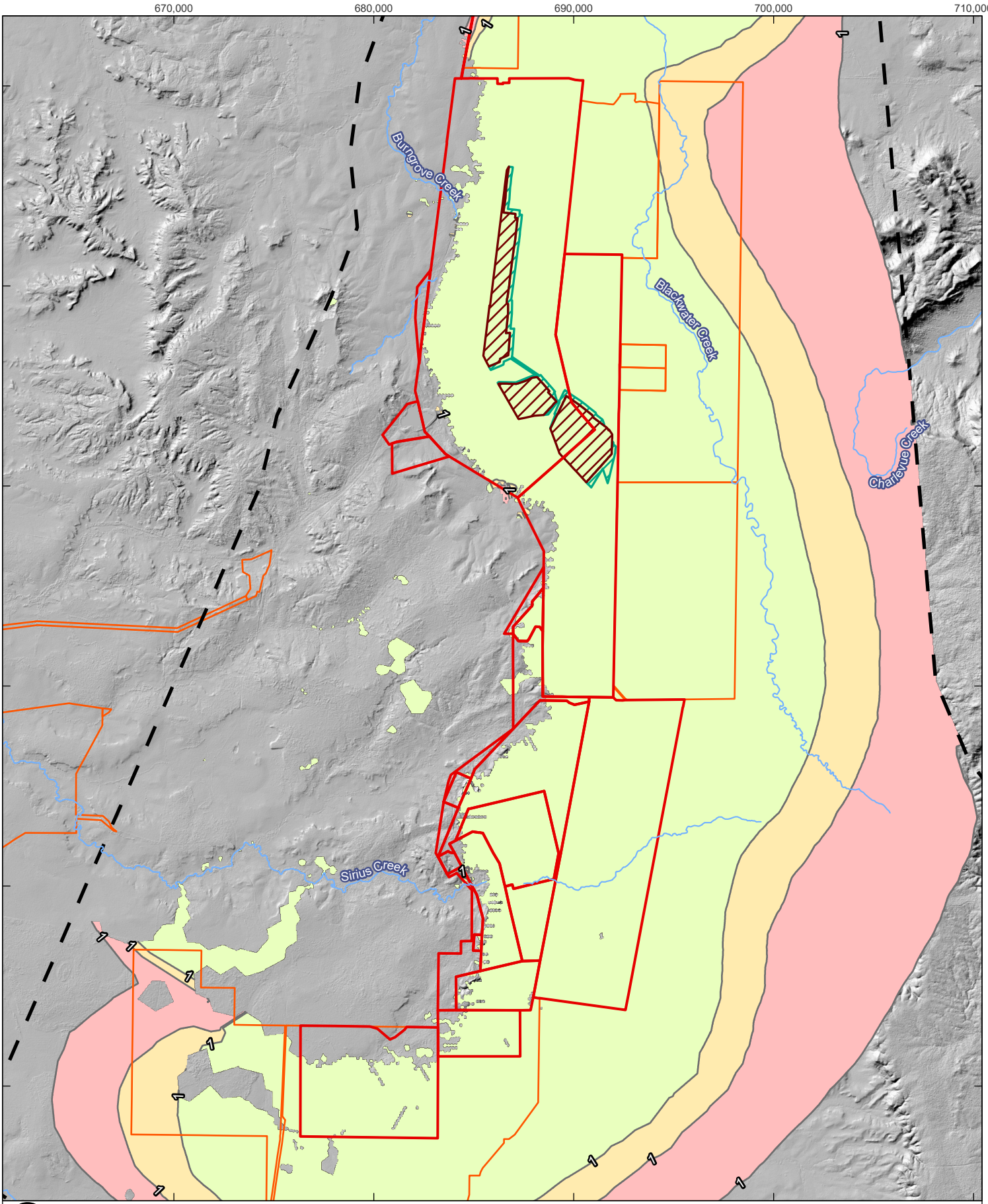
UNCERTAINTY IN PREDICTED 1M CUMULATIVE DRAWDOWN IN ARIES SEAM (END OF RECOVERY) (LAYER 8)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-16

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E16_Uncertainty in Predicted 1m Cumulative DD in Aries Seam (EoR) L8



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

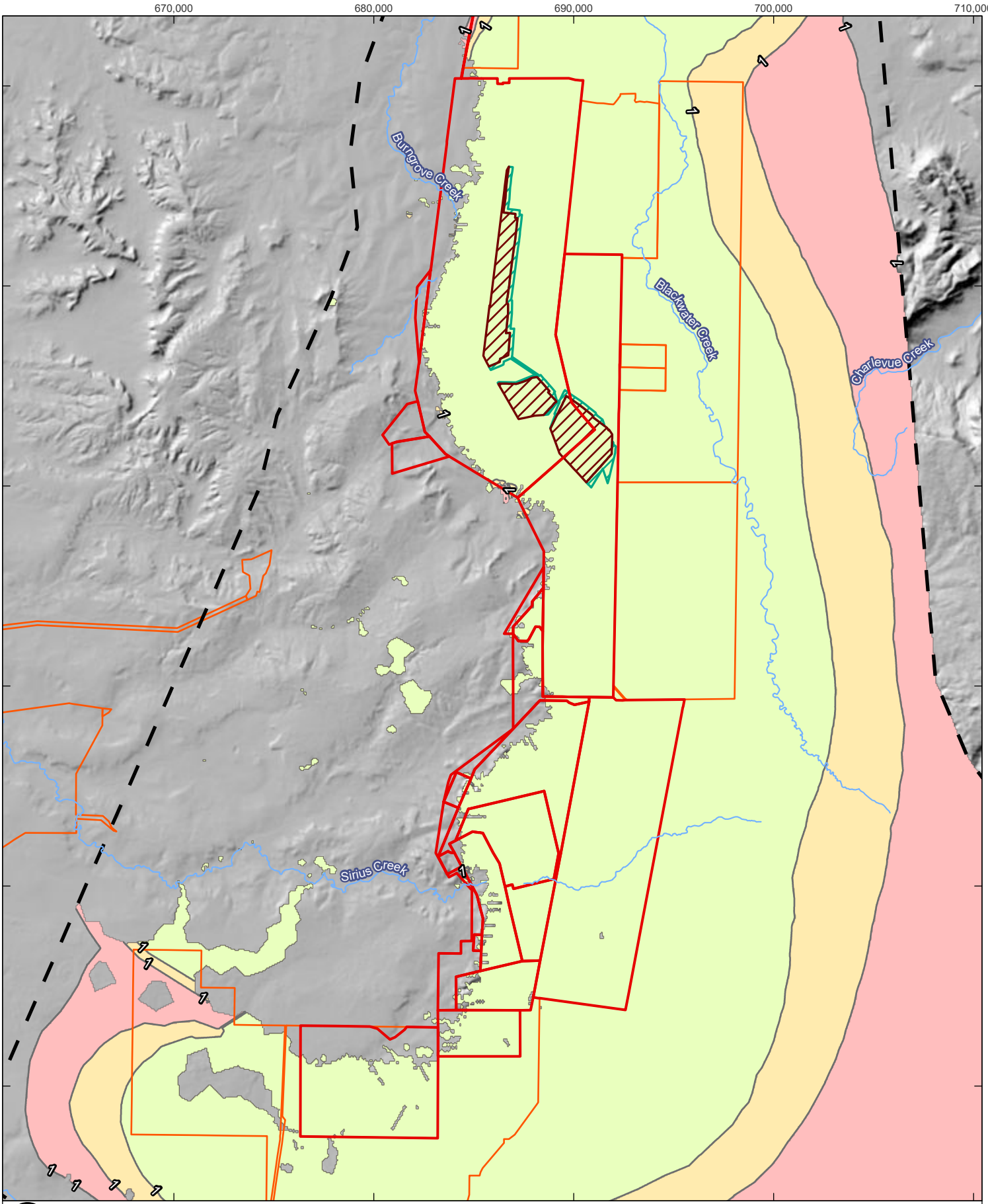
UNCERTAINTY IN PREDICTED 1M CUMULATIVE DRAWDOWN IN POLLUX SEAM (END OF MINING) (LAYER 12)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-17

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E17_Uncertainty in Predicted 1m Cumulative DD in Pollux Seam (EoM) L12



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	08-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

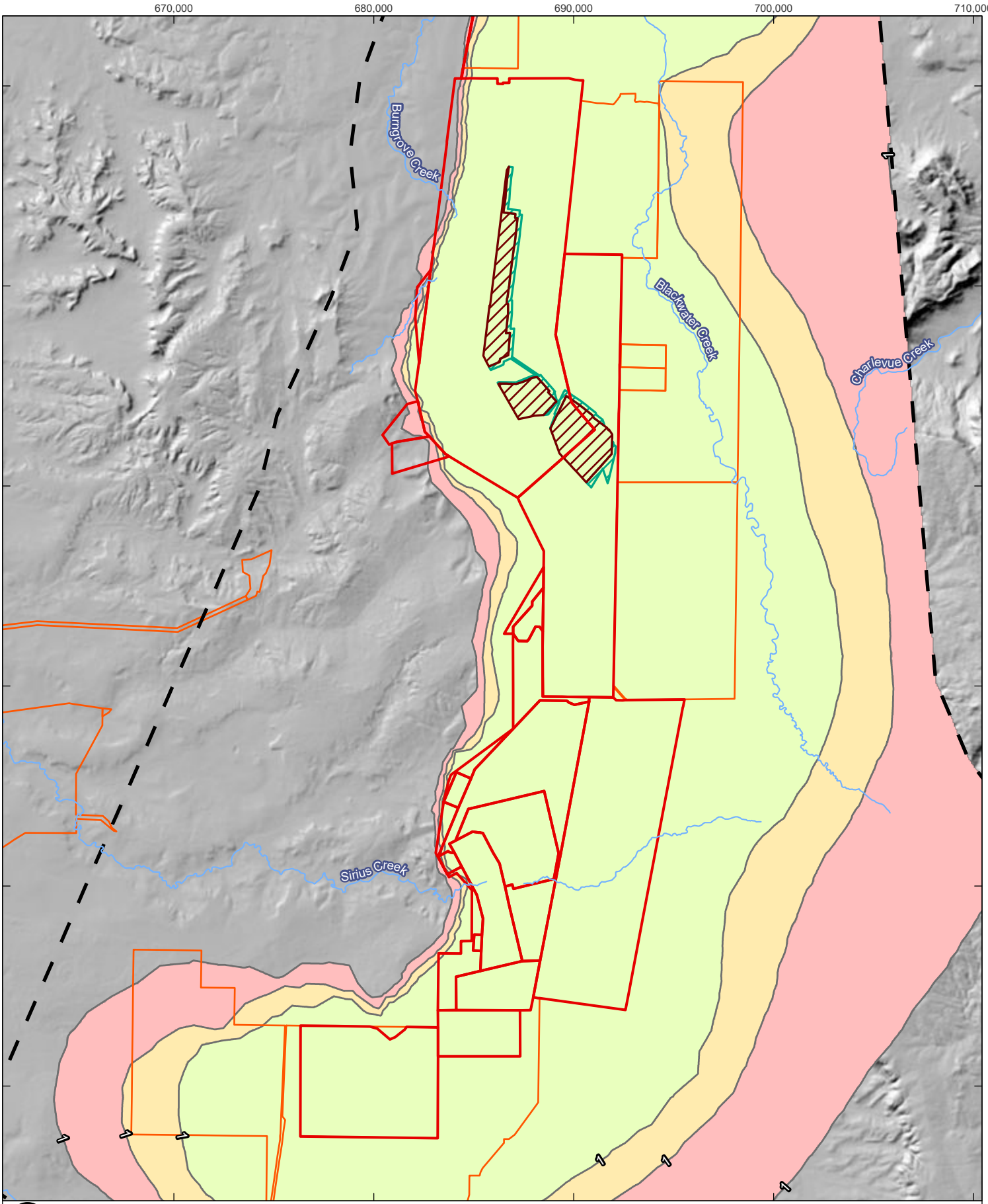
UNCERTAINTY IN PREDICTED 1M CUMULATIVE DRAWDOWN IN POLLUX SEAM (END OF RECOVERY) (LAYER 12)

SLR

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APPENDIX G-18

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E18_Uncertainty in Predicted 1m Cumulative DD in Pollux Seam (EoR) L12



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	08-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

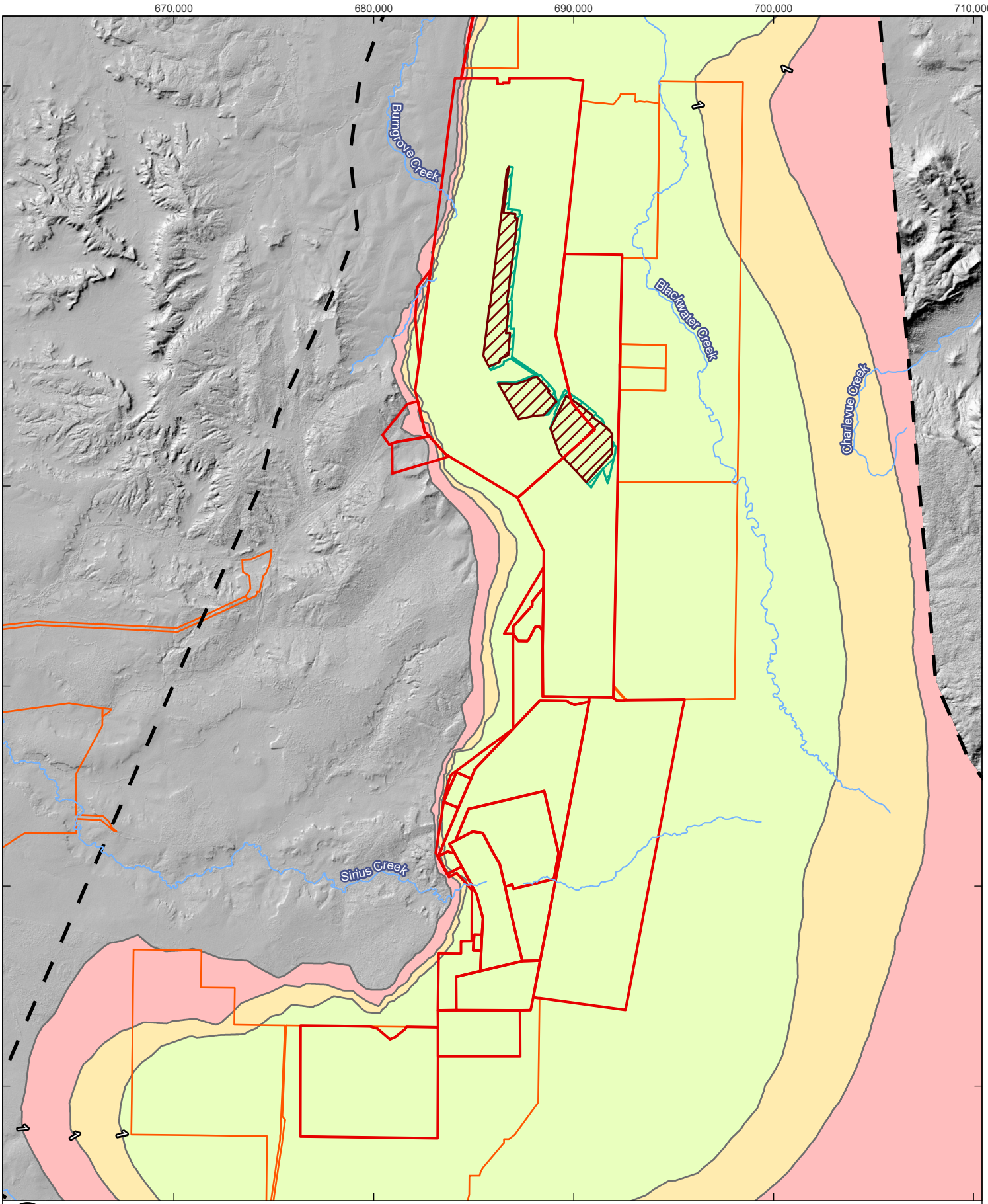
UNCERTAINTY IN PREDICTED 1M CUMULATIVE DRAWDOWN IN BURNGROVE FORMATION (END OF MINING) (LAYER 16)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-19

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E19_Uncertainty in Predicted 1m Cumulative DD in Burngrove Formation (EoM) L16



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	640.031809.00001
Date Drawn:	10-Apr-2026
Drawn by:	RB

LEGEND

- Watercourse
- BWM Mining Lease
- Mining Lease
- Model Boundary
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Maximum Drawdown (m)

- 5th Percentile
- 50th Percentile
- 95th Percentile

BLACKWATER NORTH EXTENSION PROJECT GROUNDWATER MODELLING TECHNICAL REPORT

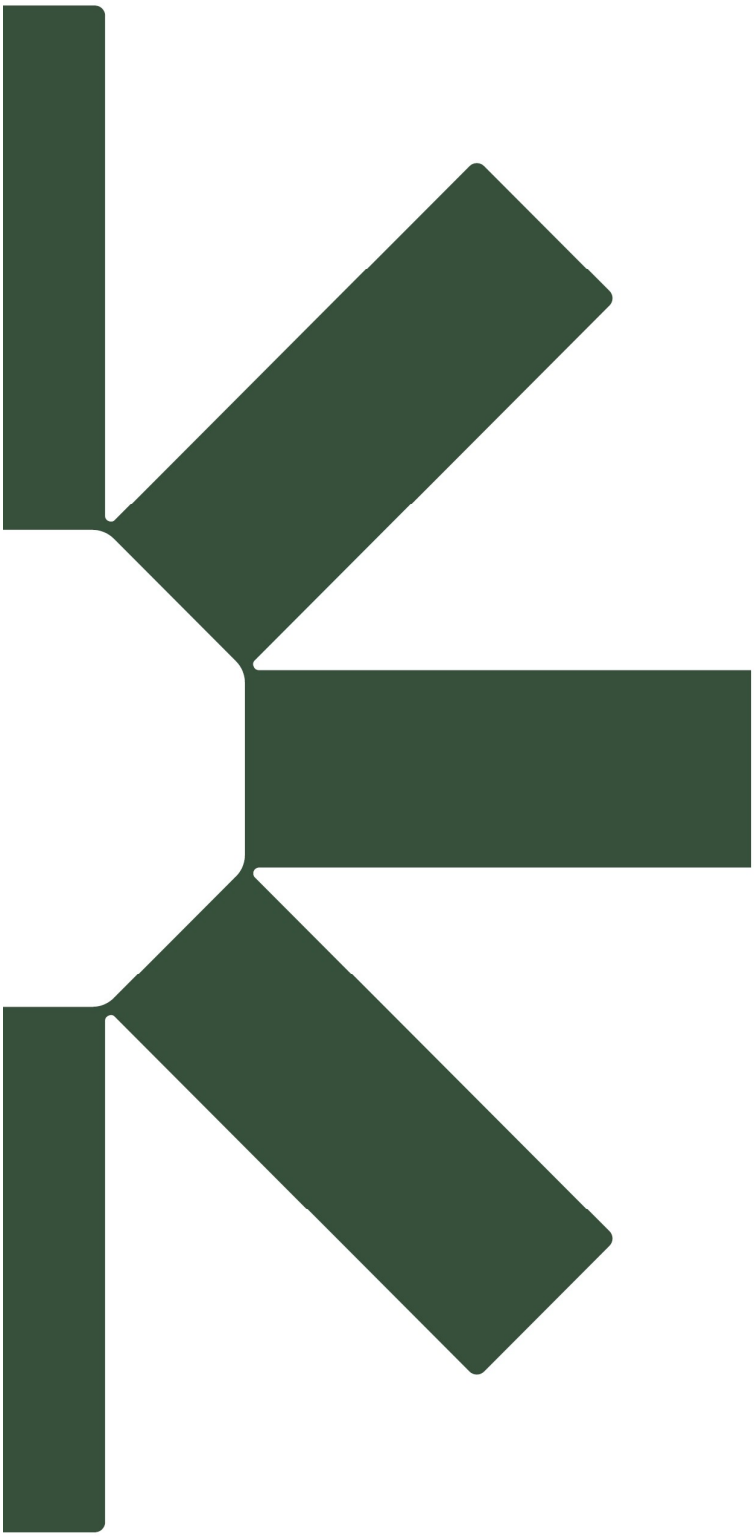
UNCERTAINTY IN PREDICTED 1M CUMULATIVE DRAWDOWN IN BURNGROVE FORMATION (END OF RECOVERY) (LAYER 16)

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

APPENDIX G-20

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031809.00001 BWM North EIS - Groundwater As\06 SLR Data\01 GIS\640_031809_BWN_EIS.aprx\640031809_MOD_APP_E20_Uncertainty in Predicted 1m Cumulative DD in Burngrove Formation (EoR) L16



Making Sustainability Happen

Appendix C Post Mining Period Starting Heads

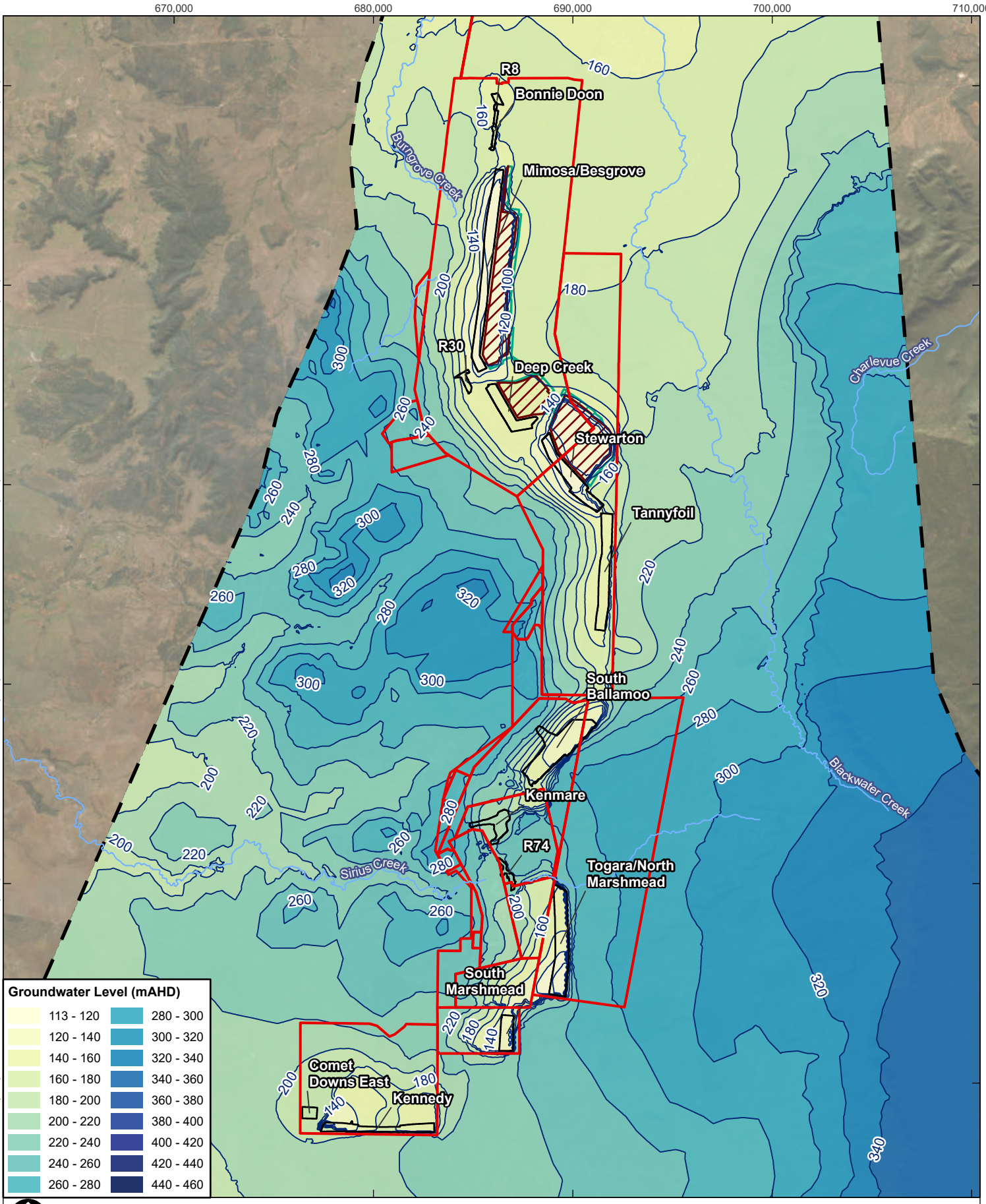
Blackwater Mine

PRC Plan Hydrogeology Assessment – Revision 3

Whitehaven Blackwater Pty Ltd

SLR Project No.: 620.040199.00017

28 September 2026



Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	08-May-2026
Drawn by:	AS

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

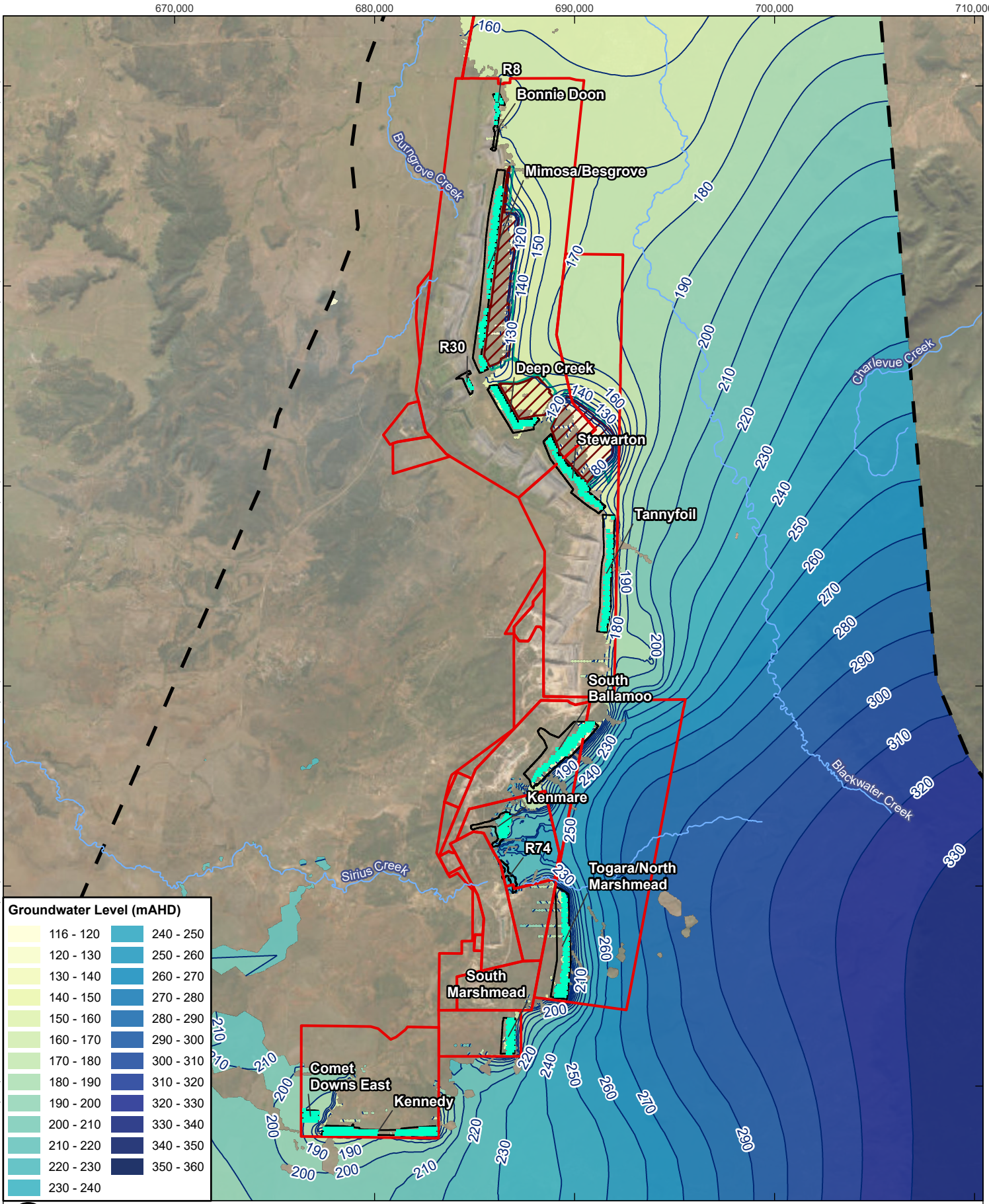
END OF MINING GROUNDWATER LEVELS – WATER TABLE

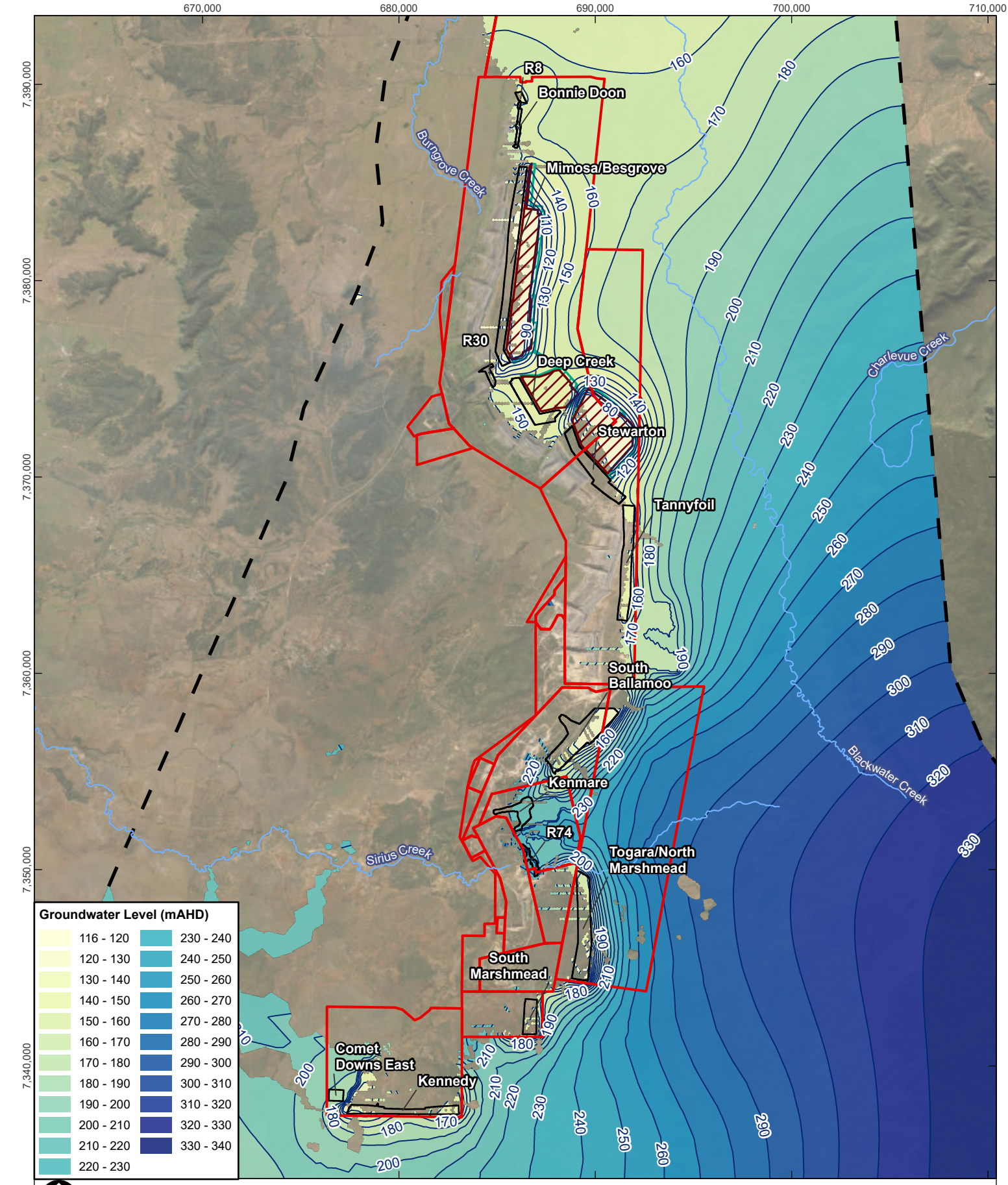
SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE C-1

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_AppC_01_End of Mining Groundwater Levels – Water Table


670,000
680,000
690,000
700,000
710,000
7,390,000
7,380,000
7,370,000
7,360,000
7,350,000
7,340,000
R8
Bonnie Doon
Mimosa/Besgrove
Burngrove Creek
R30
Deep Creek
Stewarton
Tannyfoil
Charlevue Creek
South Ballamoo
Kenmare
R74
Togara/North Marshmead
Sirius Creek
Blackwater Creek
South Marshmead
Comet Downs East
Kennedy
Groundwater Level (mAHD)
116 - 120
120 - 130
130 - 140
140 - 150
150 - 160
160 - 170
170 - 180
180 - 190
190 - 200
200 - 210
210 - 220
220 - 230
230 - 240
240 - 250
250 - 260
260 - 270
270 - 280
280 - 290
290 - 300
300 - 310
310 - 320
320 - 330
330 - 340
340 - 350
350 - 360
0
2.5
5
km
LEGEND
Watercourse
Groundwater Level (mAHD)
BWM Mining Lease
GIA Study Area
Void Extent
Void Lake
Proposed Open Cut Extension
Proposed Infrastructure Area
Coordinate System: GDA2020 MGA Zone 55
Scale: 1:250,000 at A4
Project Number: 620.040199
Date Drawn: 08-May-2026
Drawn by: AS
BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT
END OF MINING GROUNDWATER LEVELS – ARIES SEAM
SLR
DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.
FIGURE C-2
Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_AppC_02_End of Mining Groundwater Levels – Aries Seam



LEGEND

- Watercourse
- Groundwater Level (mAHD)
- BWM Mining Lease
- GIA Study Area
- Void Extent
- Void Lake
- Proposed Open Cut Extension
- Proposed Infrastructure Area

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	08-May-2026
Drawn by:	AS

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

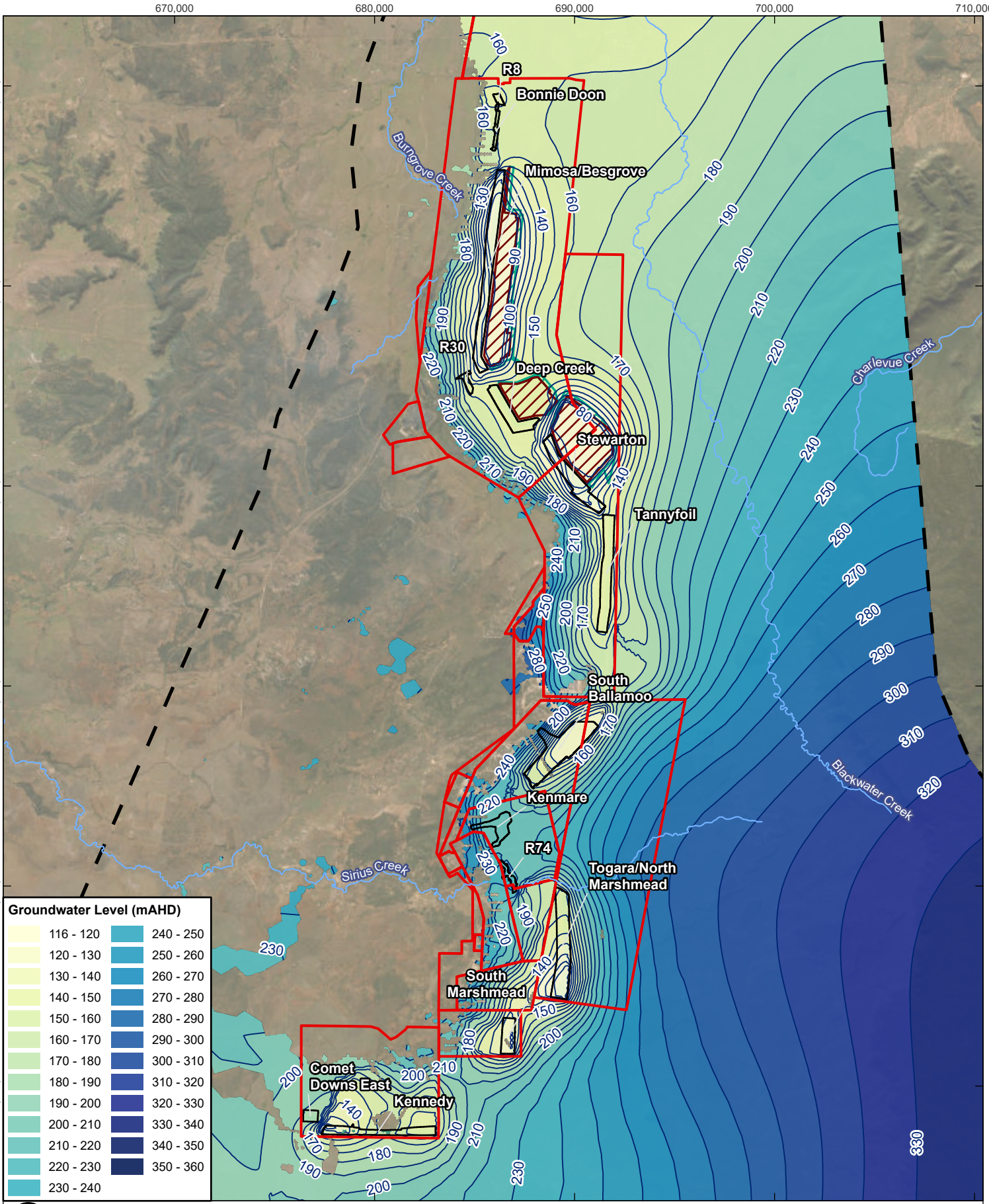
END OF MINING GROUNDWATER LEVELS – CASTOR SEAM

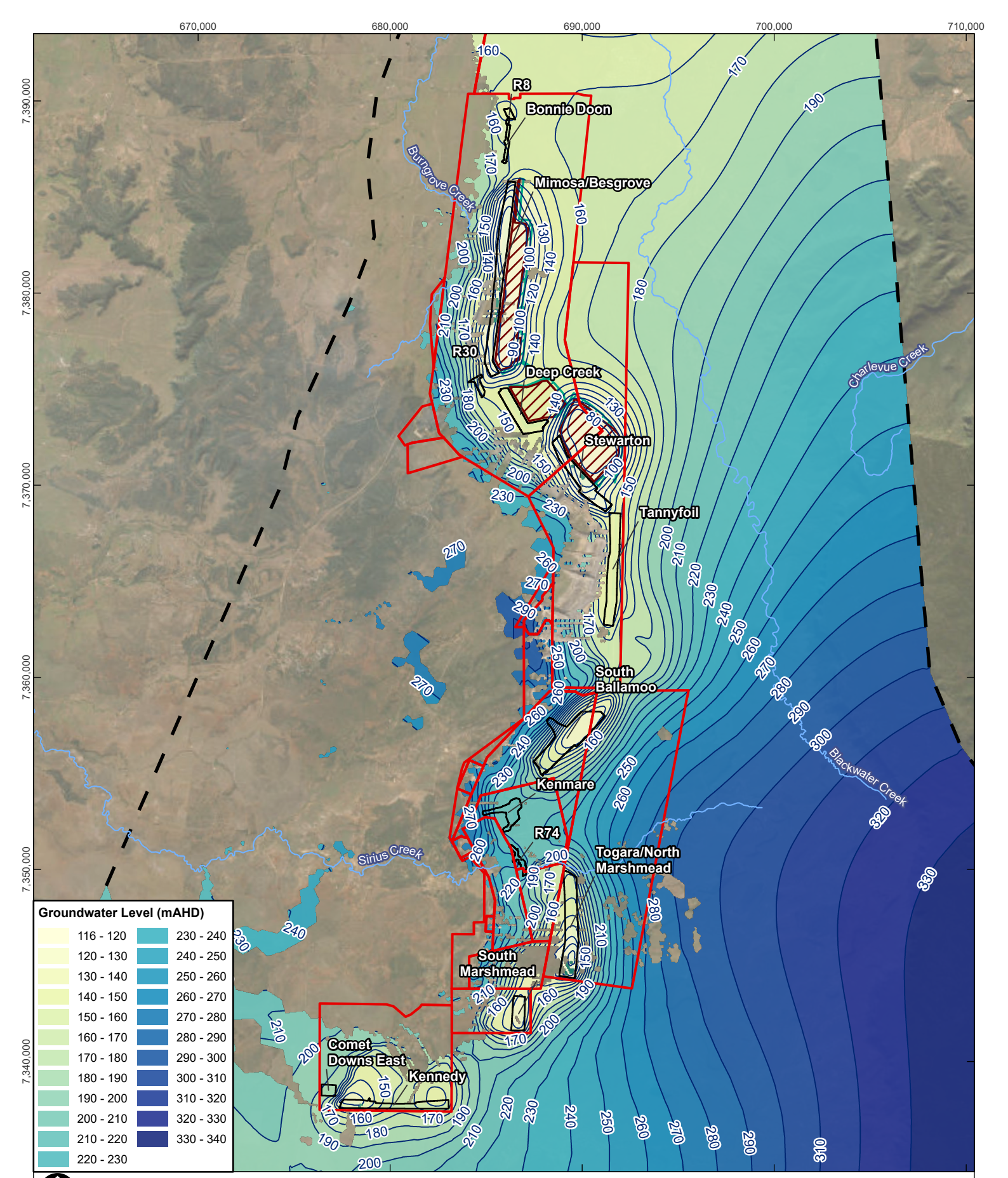
SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE C-3

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_AppC_03_End of Mining Groundwater Levels – Castor Seam


670,000
680,000
690,000
700,000
710,000
7,390,000
7,380,000
7,370,000
7,360,000
7,350,000
7,340,000
R8
Bonnie Doon
Mimosa/Besgrove
R30
Deep Creek
Stewarton
Tannyfoil
South Ballamoo
Kenmare
R74
Togara/North Marshmead
South Marshmead
Comet Downs East
Kennedy
Burngrove Creek
Sirius Creek
Charlevue Creek
Blackwater Creek
Groundwater Level (mAHD)
116 - 120
120 - 130
130 - 140
140 - 150
150 - 160
160 - 170
170 - 180
180 - 190
190 - 200
200 - 210
210 - 220
220 - 230
230 - 240
240 - 250
250 - 260
260 - 270
270 - 280
280 - 290
290 - 300
300 - 310
310 - 320
320 - 330
330 - 340
340 - 350
350 - 360
0
2.5
5
km
LEGEND
Watercourse
Groundwater Level (mAHD)
BWM Mining Lease
GIA Study Area
Void Extent
Void Lake
Proposed Open Cut Extension
Proposed Infrastructure Area
Coordinate System: GDA2020 MGA Zone 55
Scale: 1:250,000 at A4
Project Number: 620.040199
Date Drawn: 08-May-2026
Drawn by: AS
BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT
END OF MINING GROUNDWATER LEVELS – POLLUX SEAM
SLR
DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.
FIGURE C-4
Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_AppC_04_End of Mining Groundwater Levels – Pollux Seam



Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:250,000 at A4
Project Number:	620.040199
Date Drawn:	08-May-2026
Drawn by:	AS

BLACKWATER MINE - PRCP HYDROGEOLOGY ASSESSMENT

END OF MINING GROUNDWATER LEVELS – BURNGROVE FORMATION

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE C-5

Path: H:\Projects-SLR\620-BNE\620-BNE\620.040199.00001 BWM PRCP – GW\03 SLR Data\01 CADGIS\GIS\ArcPro\BWM PRCP – GW\BWM PRCP – GW.aprx\620040199_AppC_05_End of Mining Groundwater Levels – Burngrove Formation

Appendix D Predictive Hydrographs Adjacent Final Void Lakes

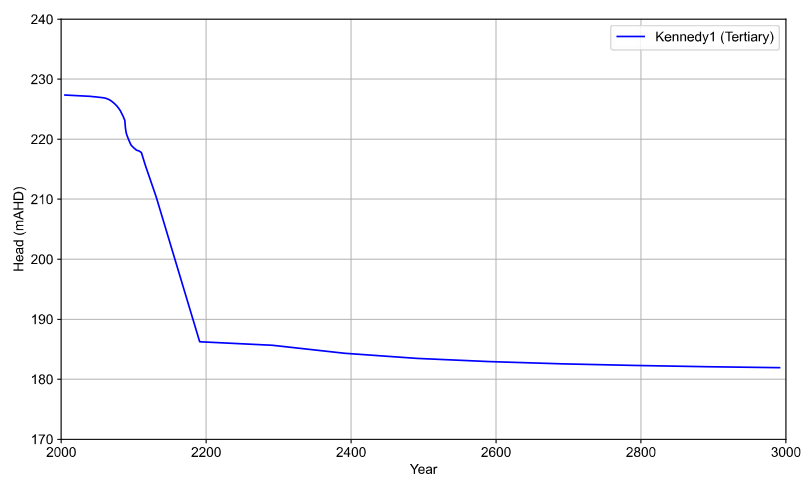
Blackwater Mine

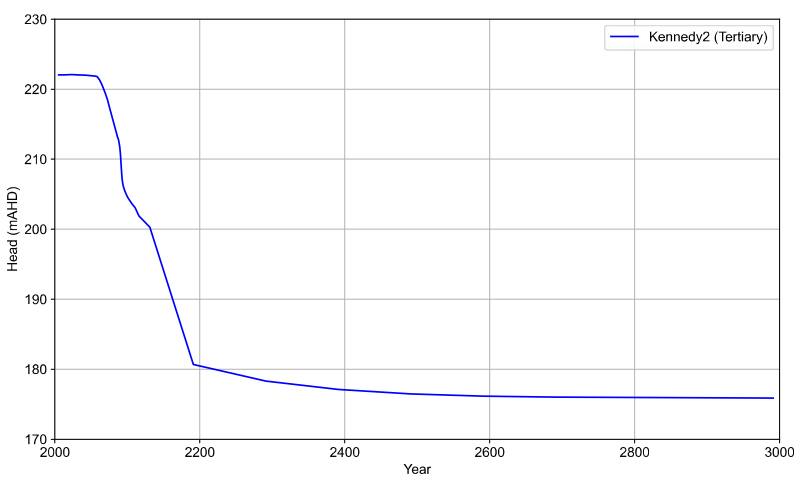
PRC Plan Hydrogeology Assessment – Revision 3

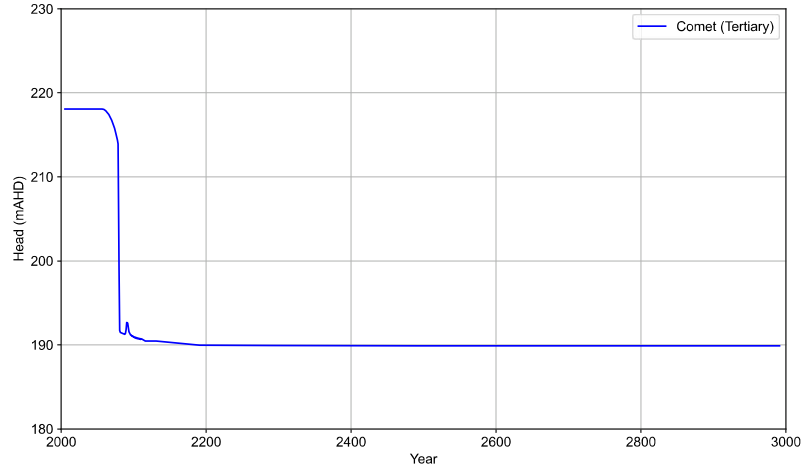
Whitehaven Blackwater Pty Ltd

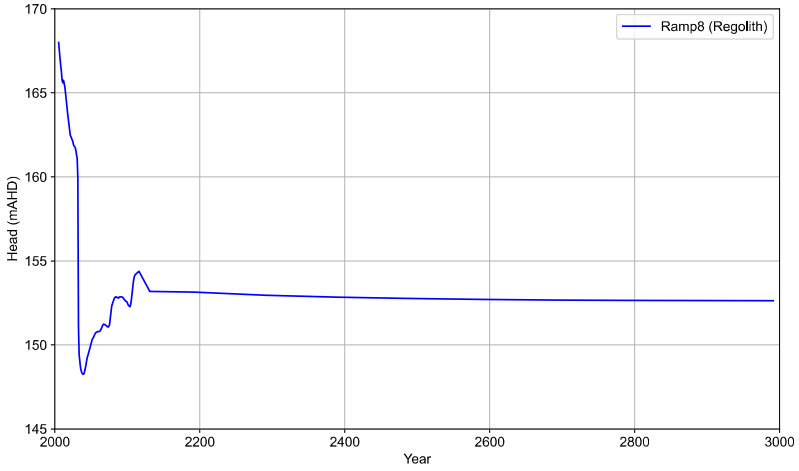
SLR Project No.: 620.040199.00017

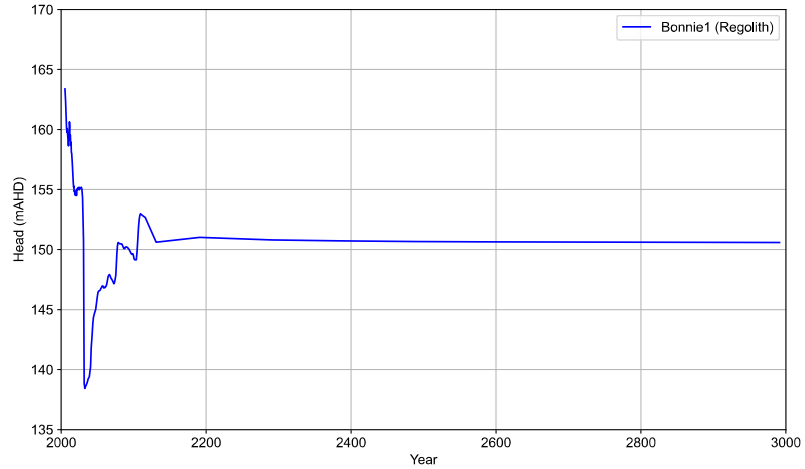
28 September 2026

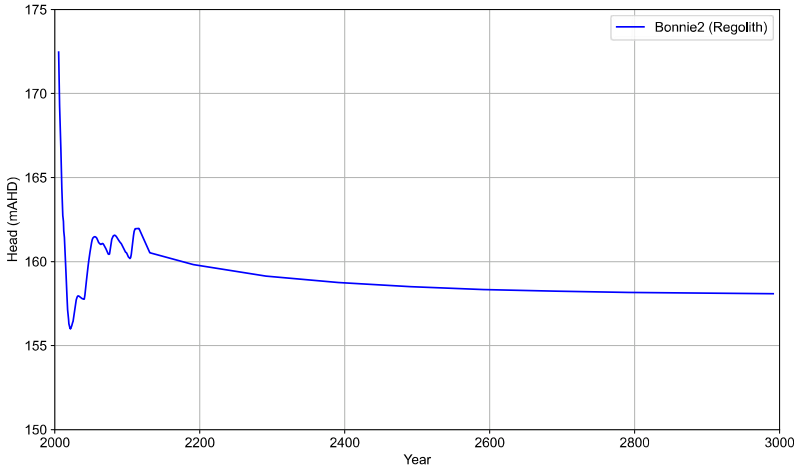

Kennedy1 (Tertiary)
Head (mAHD)
Year
240
230
220
210
200
190
180
170
2000
2200
2400
2600
2800
3000

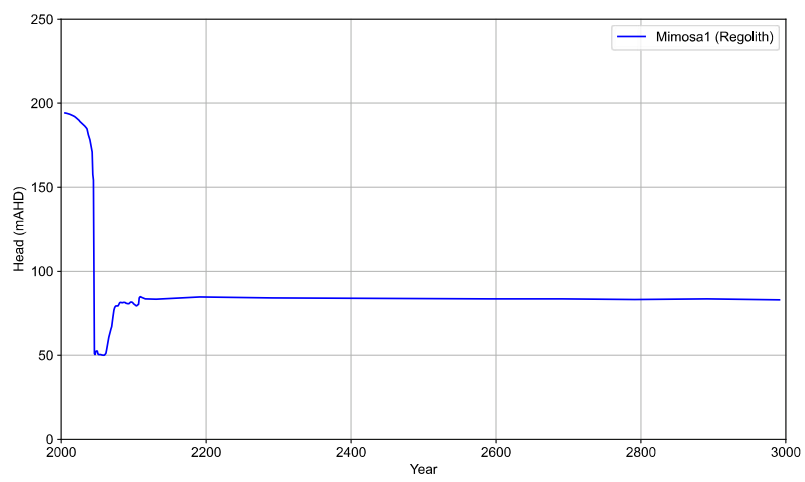

Kennedy2 (Tertiary)
Head (mAHD)
Year
230
220
210
200
190
180
170
2000
2200
2400
2600
2800
3000

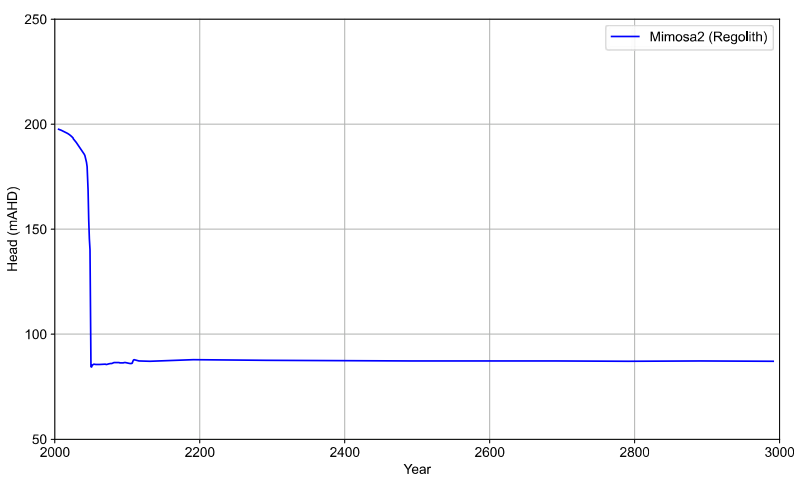

Comet (Tertiary)
Head (mAHD)
Year
230
220
210
200
190
180
2000
2200
2400
2600
2800
3000

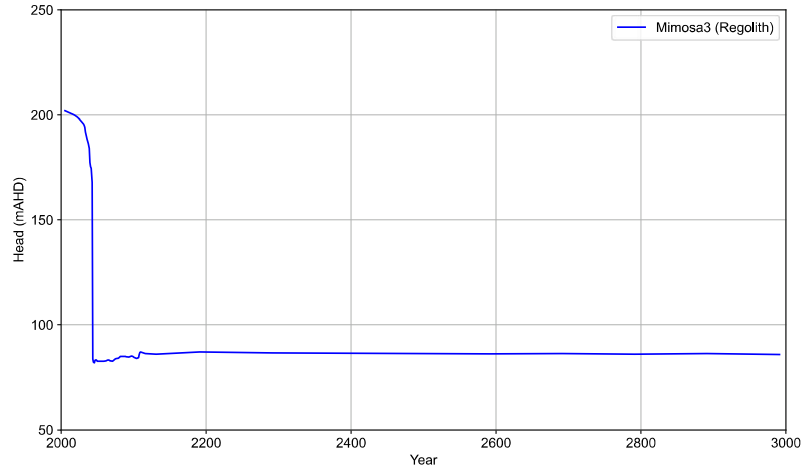

Ramp8 (Regolith)
Head (mAHD)
Year
170
165
160
155
150
145
2000
2200
2400
2600
2800
3000

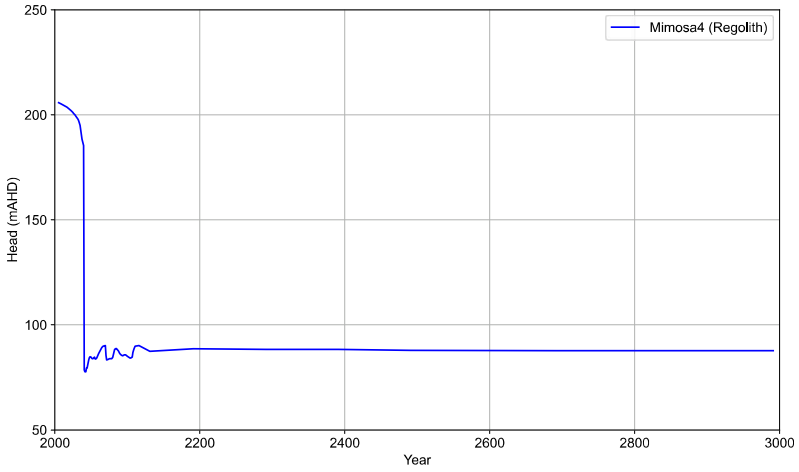

Bonnie1 (Regolith)
Head (mAHD)
Year
170
165
160
155
150
145
140
135
2000
2200
2400
2600
2800
3000

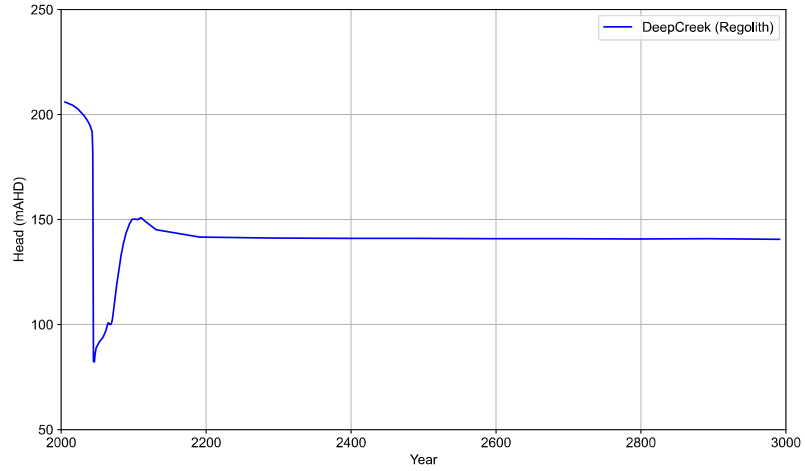

Bonnie2 (Regolith)
Head (mAHD)
Year
175
170
165
160
155
150
2000
2200
2400
2600
2800
3000

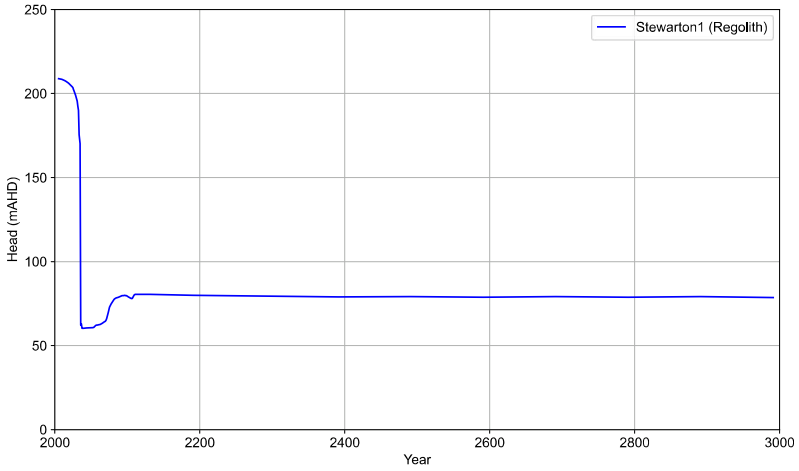

Mimosa1 (Regolith)
Head (mAHD)
Year
250
200
150
100
50
0
2000
2200
2400
2600
2800
3000

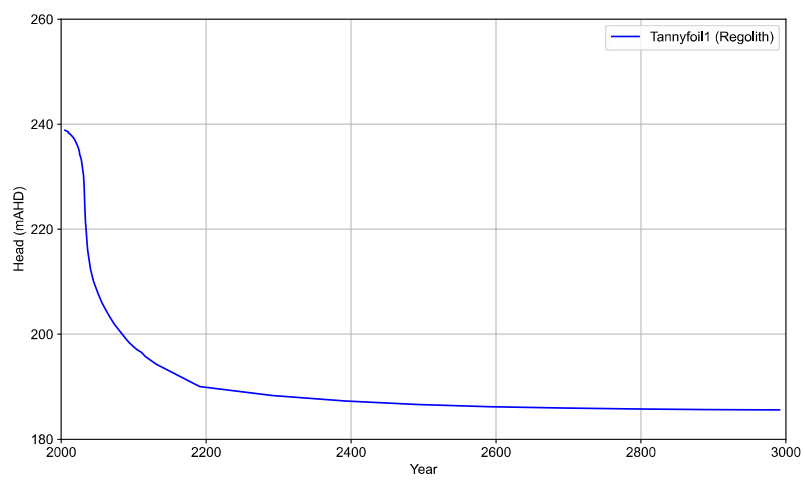

Mimosa2 (Regolith)
Head (mAHD)
Year
250
200
150
100
50
2000
2200
2400
2600
2800
3000

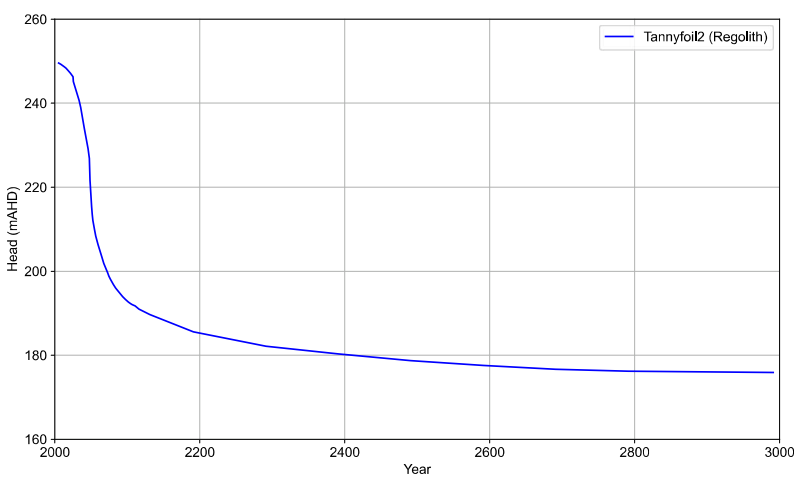

Mimosa3 (Regolith)
Head (mAHD)
Year
250
200
150
100
50
2000
2200
2400
2600
2800
3000

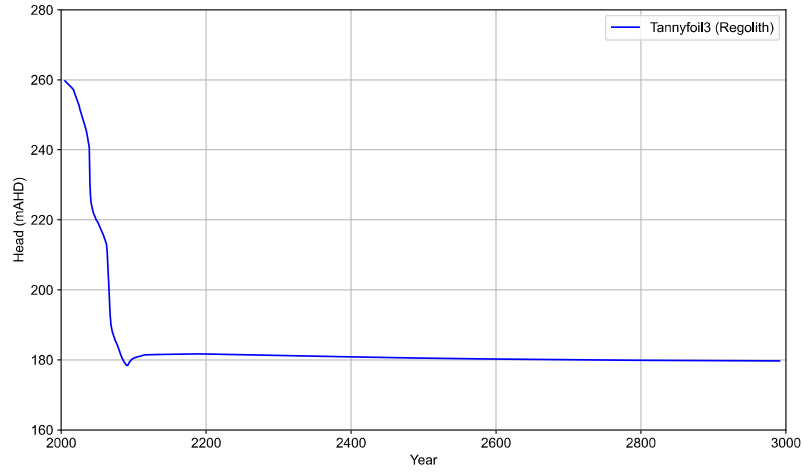

Mimosa4 (Regolith)
Head (mAHD)
Year
250
200
150
100
50
2000
2200
2400
2600
2800
3000

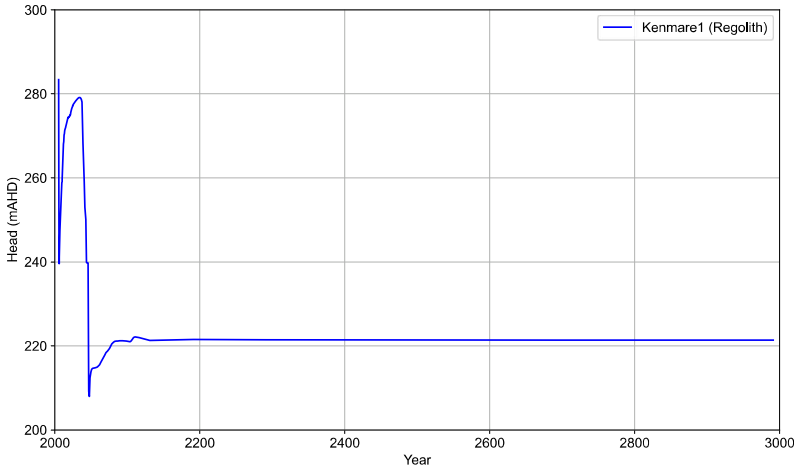

DeepCreek (Regolith)
Head (mAHD)
Year
250
200
150
100
50
2000
2200
2400
2600
2800
3000

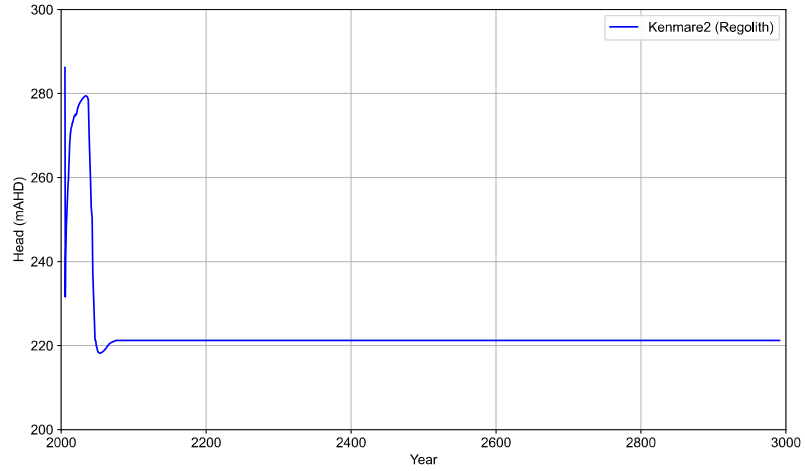

Stewarton1 (Regolith)
Head (mAHD)
Year
250
200
150
100
50
0
2000
2200
2400
2600
2800
3000

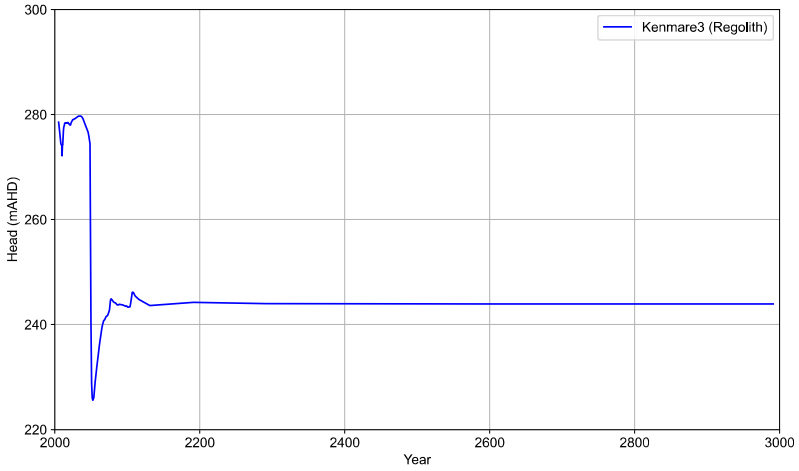

Tannyfoil1 (Regolith)
Head (mAHD)
Year
260
240
220
200
180
2000
2200
2400
2600
2800
3000

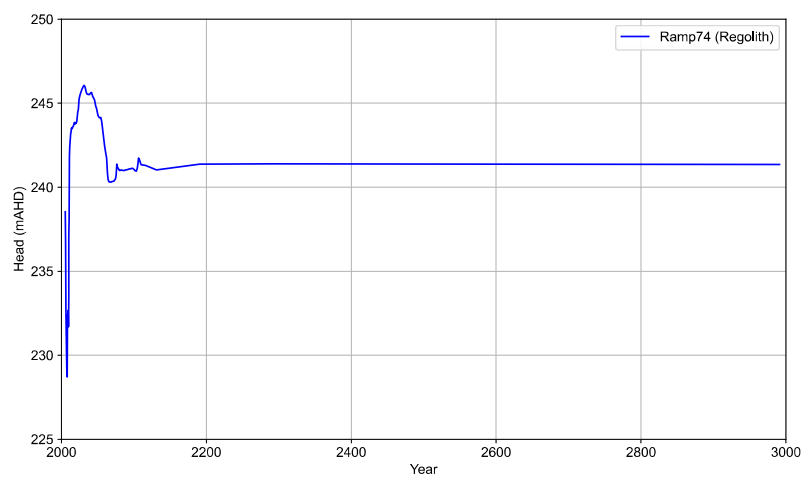

Tannyfoil2 (Regolith)
Head (mAHD)
Year
260
240
220
200
180
160
2000
2200
2400
2600
2800
3000

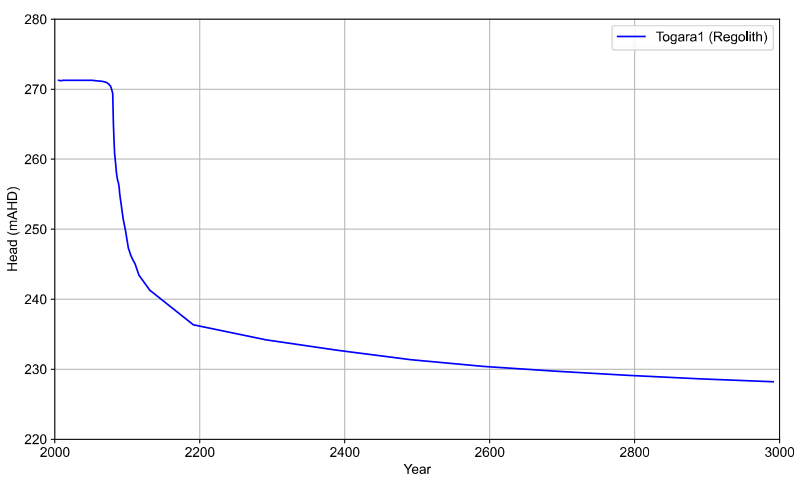

Tannyfoil3 (Regolith)
Head (mAHD)
Year
280
260
240
220
200
180
160
2000
2200
2400
2600
2800
3000

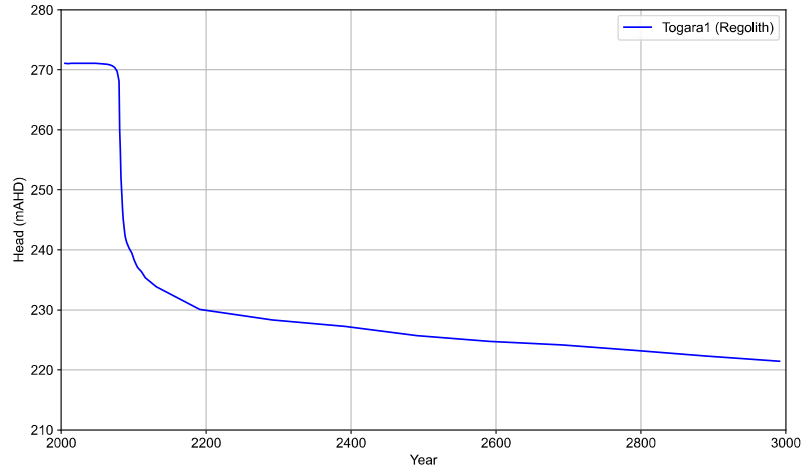

Kenmare1 (Regolith)
Head (mAHD)
Year
300
280
260
240
220
200
2000
2200
2400
2600
2800
3000

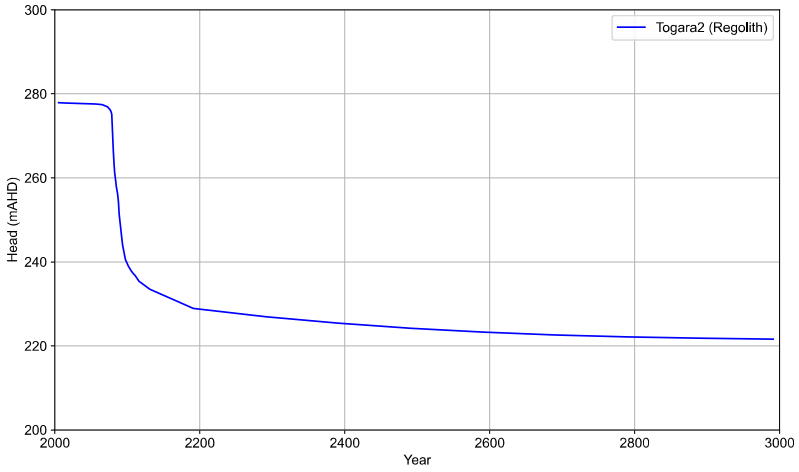

Kenmare2 (Regolith)
Head (mAHD)
Year
300
280
260
240
220
200
2000
2200
2400
2600
2800
3000

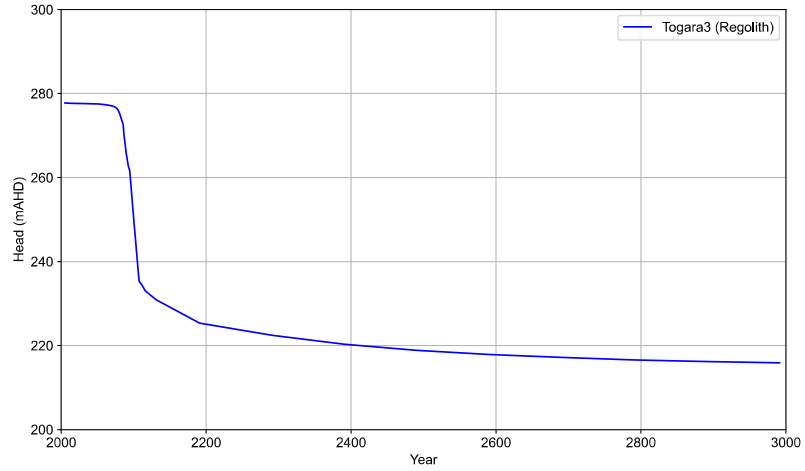

Kenmare3 (Regolith)
Head (mAHD)
Year
300
280
260
240
220
2000
2200
2400
2600
2800
3000

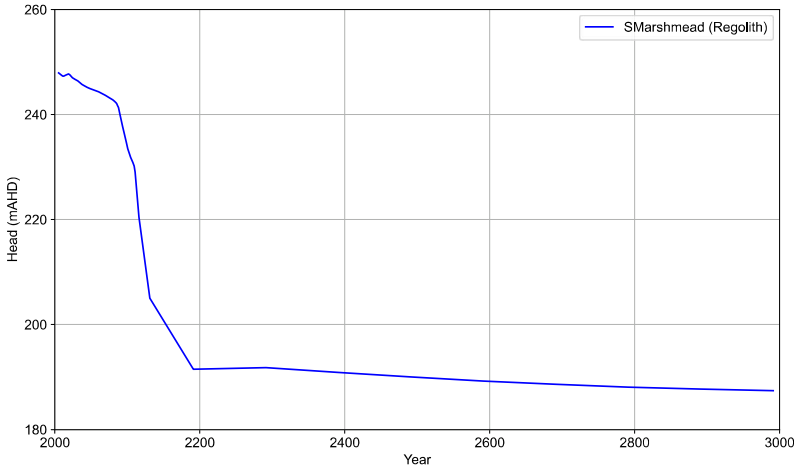

Ramp74 (Regolith)
Head (mAHD)
Year
250
245
240
235
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2400
2600
2800
3000

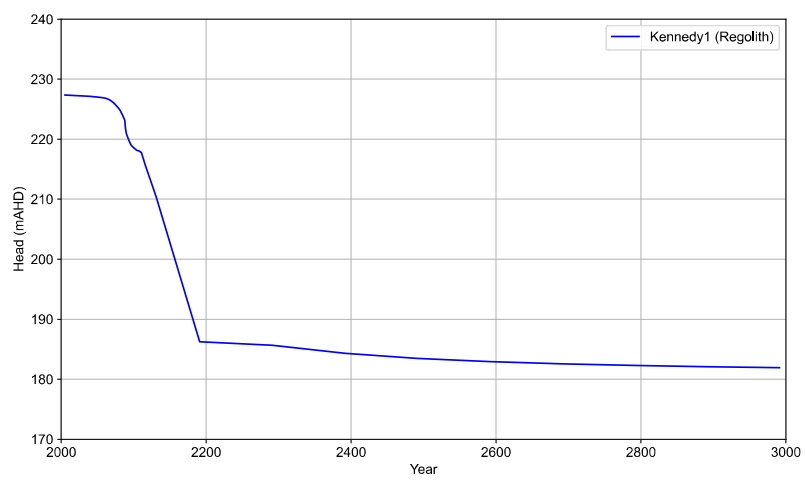

Togara1 (Regolith)
Head (mAHD)
Year
280
270
260
250
240
230
220
2000
2200
2400
2600
2800
3000

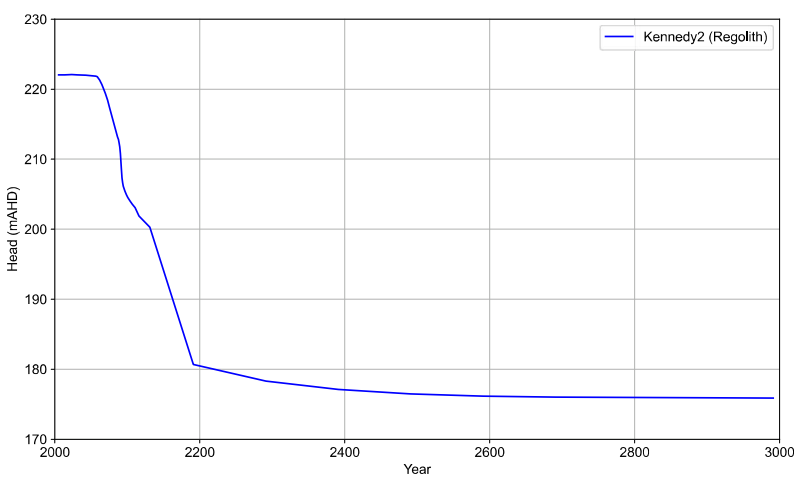

Togara1 (Regolith)
Head (mAHD)
Year
280
270
260
250
240
230
220
210
2000
2200
2400
2600
2800
3000

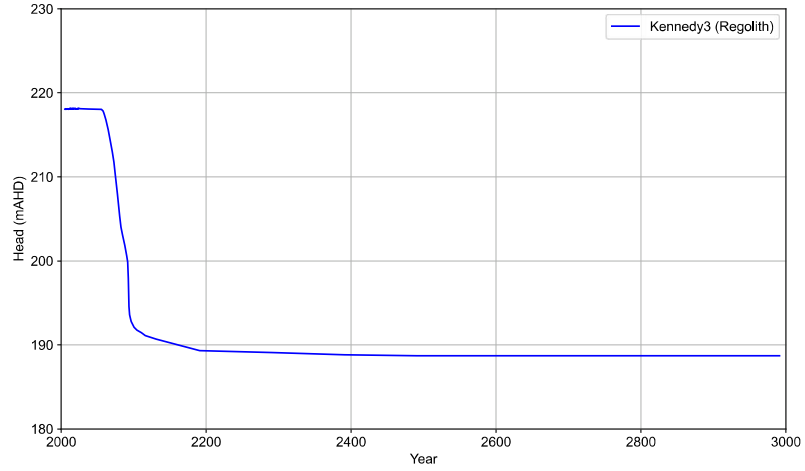

Togara2 (Regolith)
Head (mAHD)
Year
300
280
260
240
220
200
2000
2200
2400
2600
2800
3000

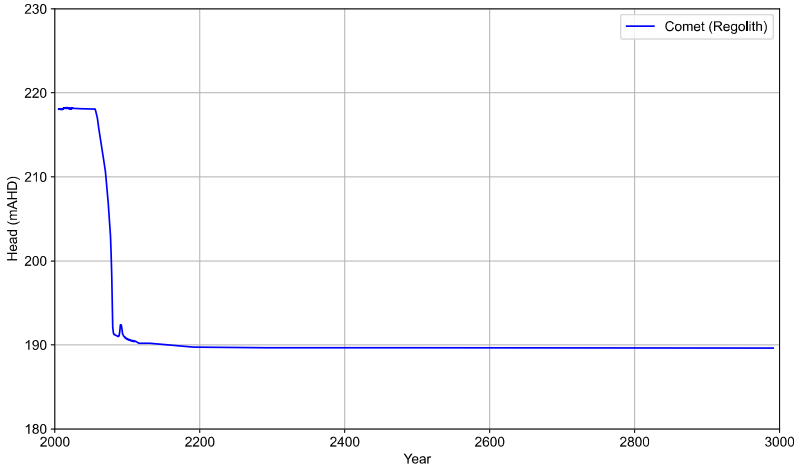

Togara3 (Regolith)
Head (mAHD)
Year
300
280
260
240
220
200
2000
2200
2400
2600
2800
3000


SMarshmead (Regolith)
Head (mAHD)
Year
260
240
220
200
180
2000
2200
2400
2600
2800
3000


Kennedy1 (Regolith)
Head (mAHD)
Year
240
230
220
210
200
190
180
170
2000
2200
2400
2600
2800
3000


Kennedy2 (Regolith)
Head (mAHD)
Year
230
220
210
200
190
180
170
2000
2200
2400
2600
2800
3000


Kennedy3 (Regolith)
Head (mAHD)
Year
230
220
210
200
190
180
2000
2200
2400
2600
2800
3000


Comet (Regolith)
Head (mAHD)
Year
230
220
210
200
190
180
2000
2200
2400
2600
2800
3000

Appendix E Predictive Hydrographs at Third-Party Bores

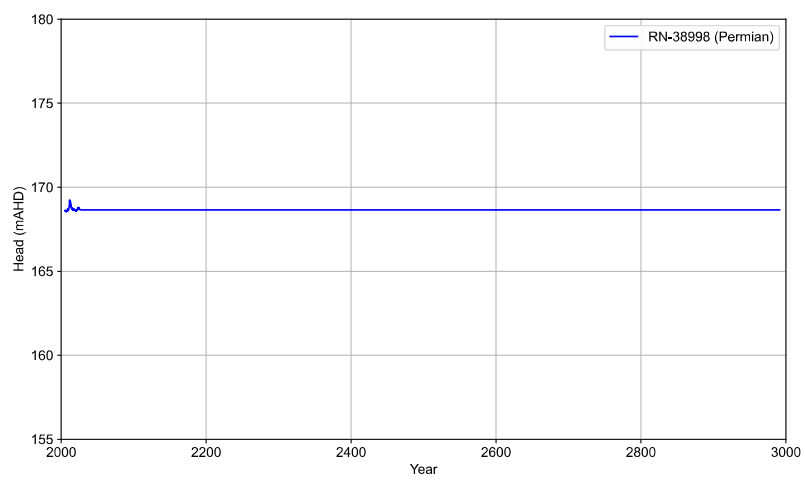
Blackwater Mine

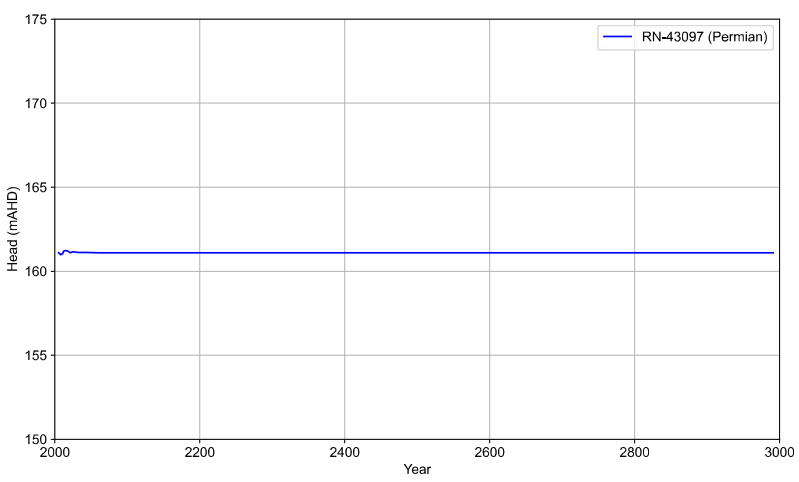
PRC Plan Hydrogeology Assessment – Revision 3

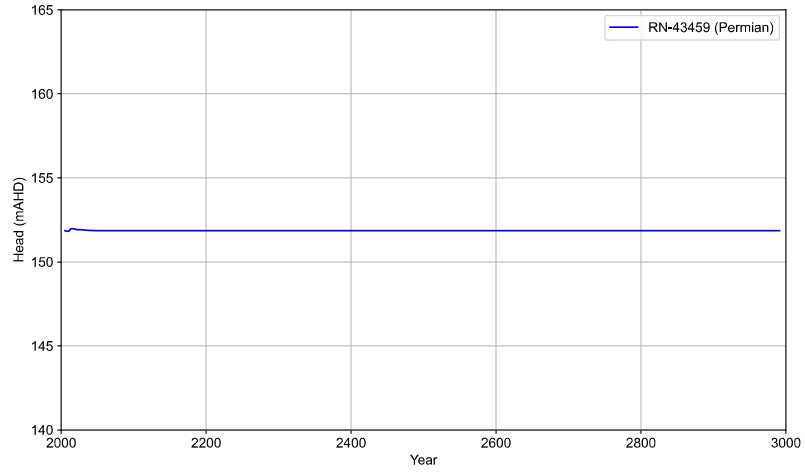
Whitehaven Blackwater Pty Ltd

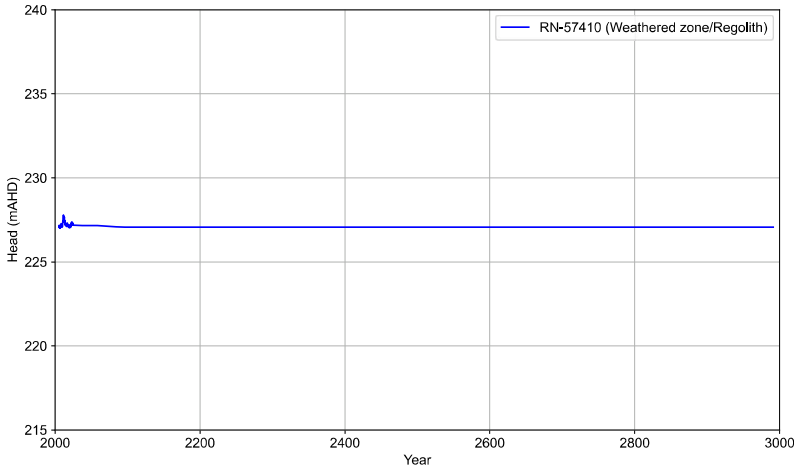
SLR Project No.: 620.040199.00017

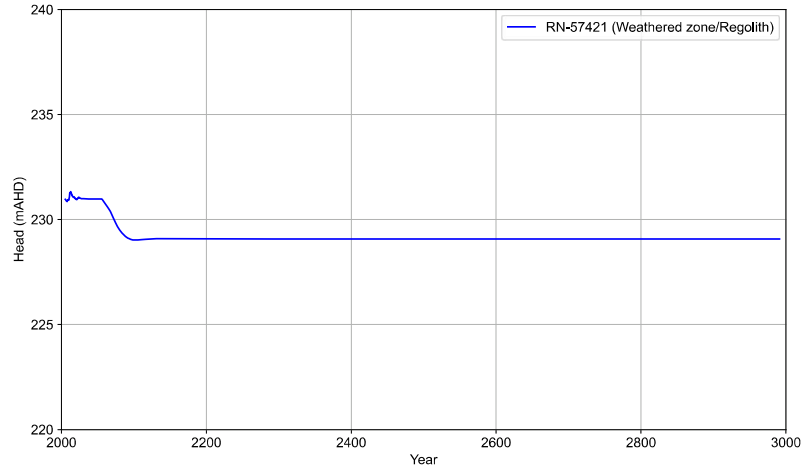
28 September 2026

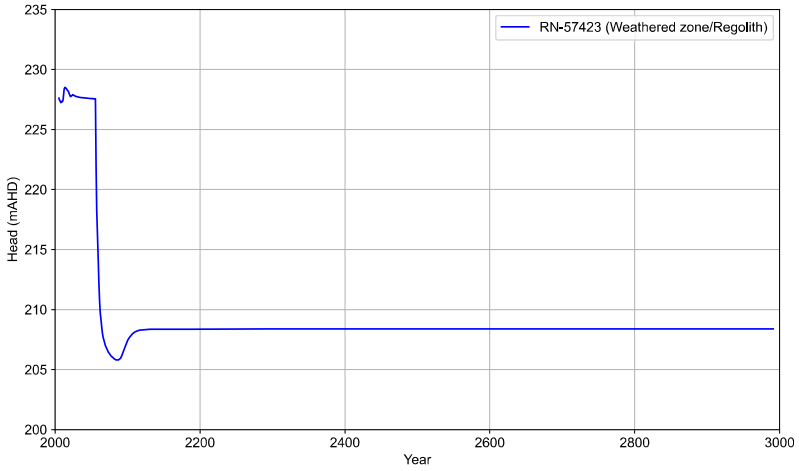

RN-38998 (Permian)
Head (mAHD)
Year
180
175
170
165
160
155
2000
2200
2400
2600
2800
3000

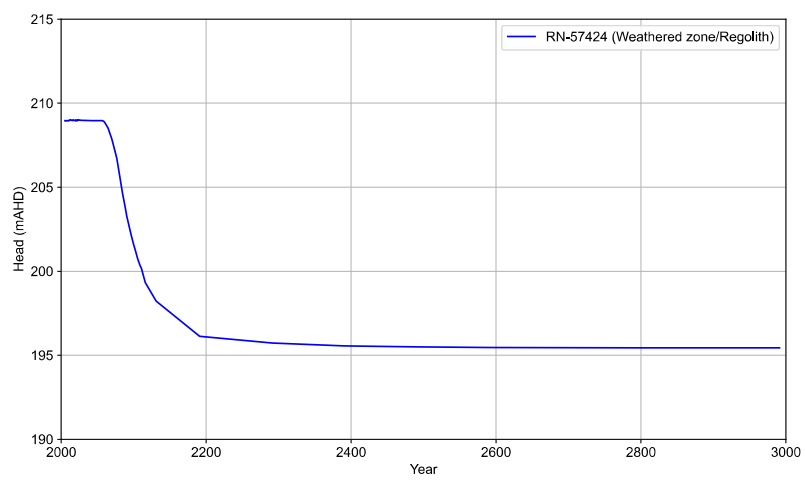

RN-43097 (Permian)
Head (mAHD)
Year
175
170
165
160
155
150
2000
2200
2400
2600
2800
3000

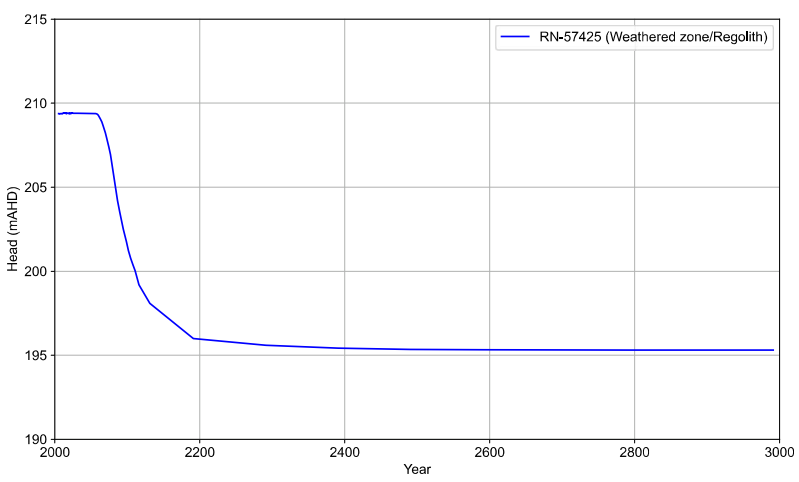

RN-43459 (Permian)
Head (mAHD)
Year
165
160
155
150
145
140
2000
2200
2400
2600
2800
3000

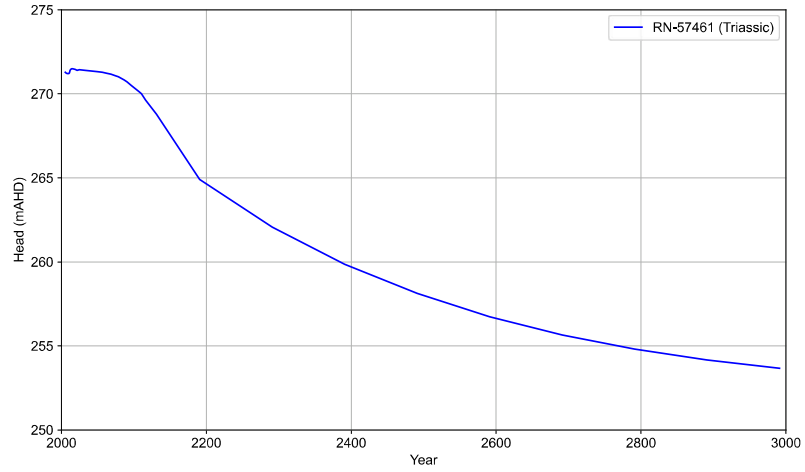

RN-57410 (Weathered zone/Regolith)
Head (mAHD)
Year
240
235
230
225
220
215
2000
2200
2400
2600
2800
3000

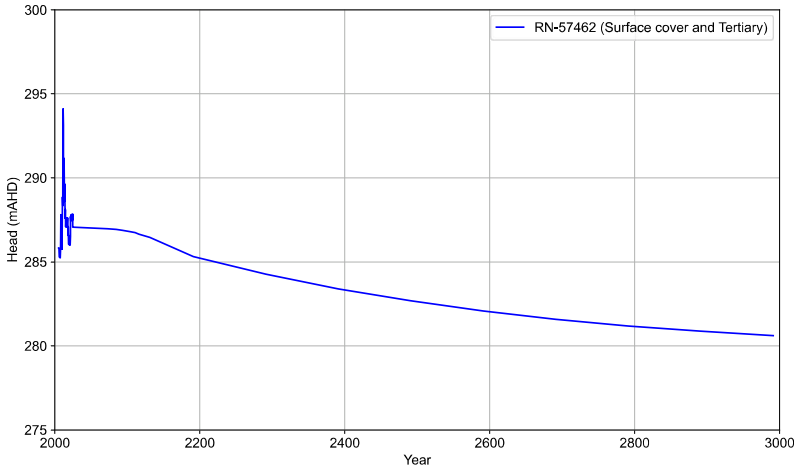

RN-57421 (Weathered zone/Regolith)
Head (mAHD)
Year
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235
230
225
220
2000
2200
2400
2600
2800
3000

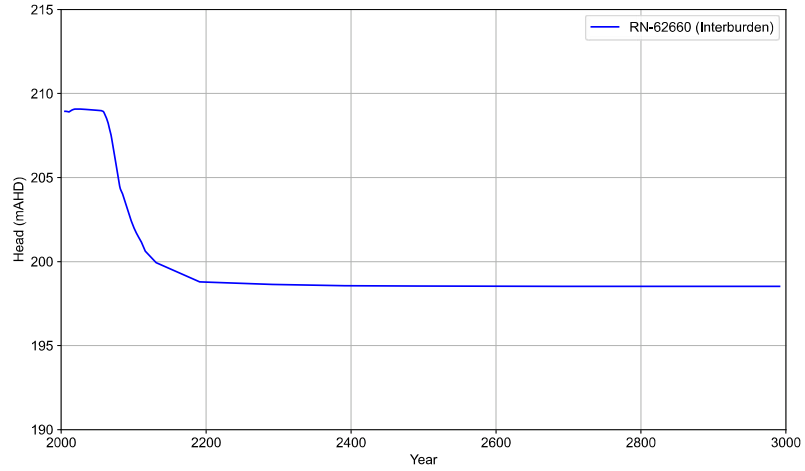

RN-57423 (Weathered zone/Regolith)
Head (mAHD)
Year
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230
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220
215
210
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200
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2200
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2600
2800
3000

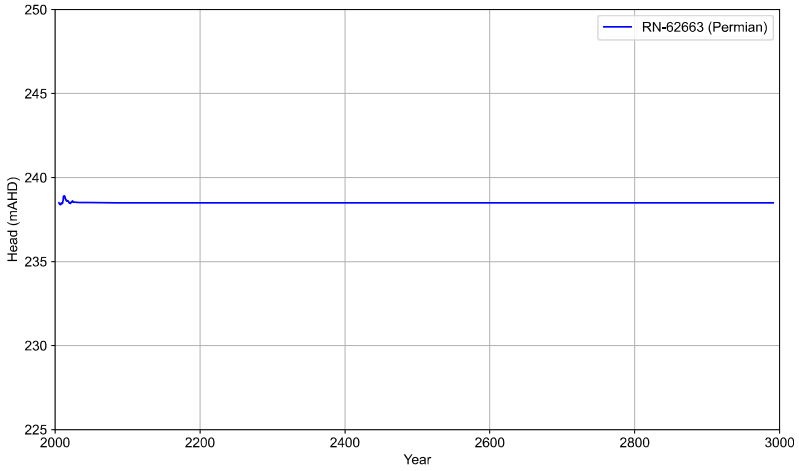

RN-57424 (Weathered zone/Regolith)
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190
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2600
2800
3000

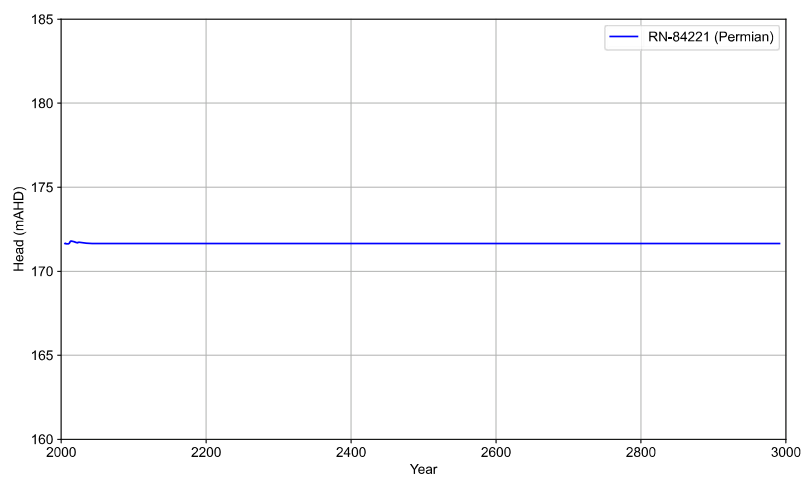

RN-57425 (Weathered zone/Regolith)
Head (mAHD)
Year
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210
205
200
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190
2000
2200
2400
2600
2800
3000

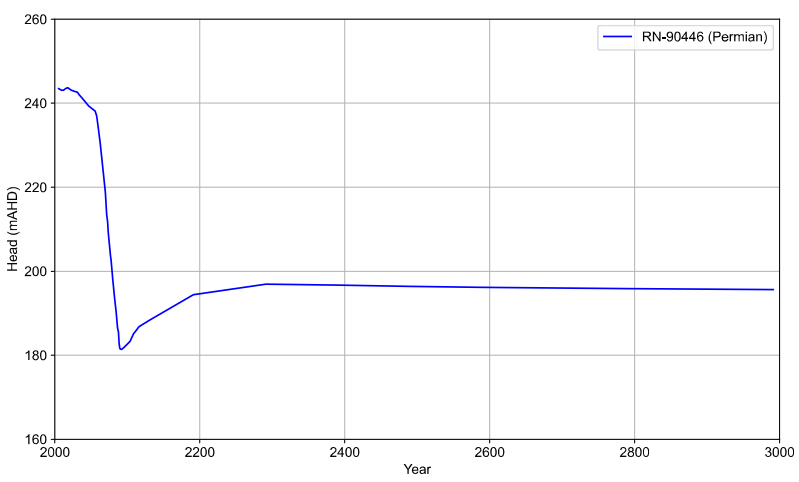

RN-57461 (Triassic)
Head (mAHD)
Year
275
270
265
260
255
250
2000
2200
2400
2600
2800
3000

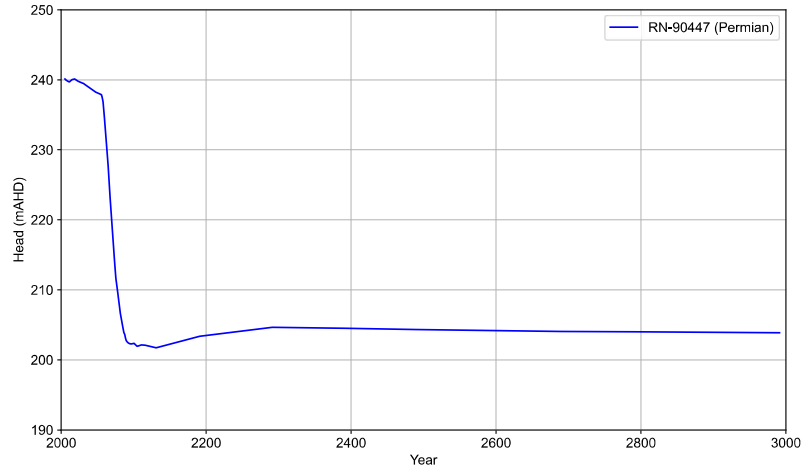

RN-57462 (Surface cover and Tertiary)
Head (mAHD)
Year
300
295
290
285
280
275
2000
2200
2400
2600
2800
3000

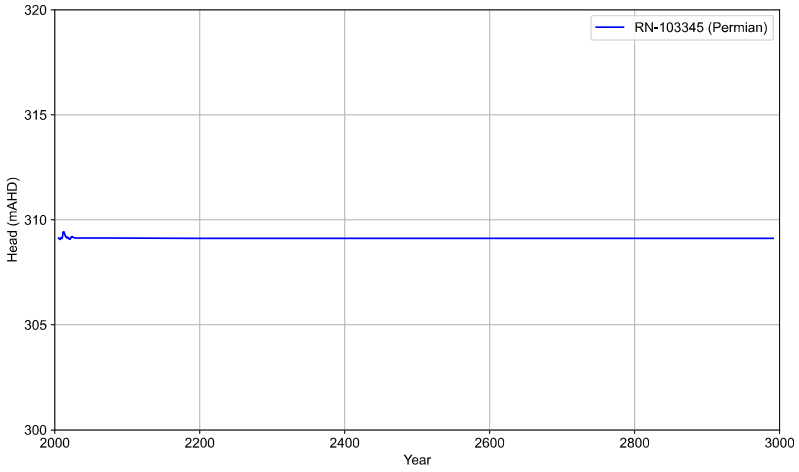

RN-62660 (Interburden)
Head (mAHD)
Year
215
210
205
200
195
190
2000
2200
2400
2600
2800
3000

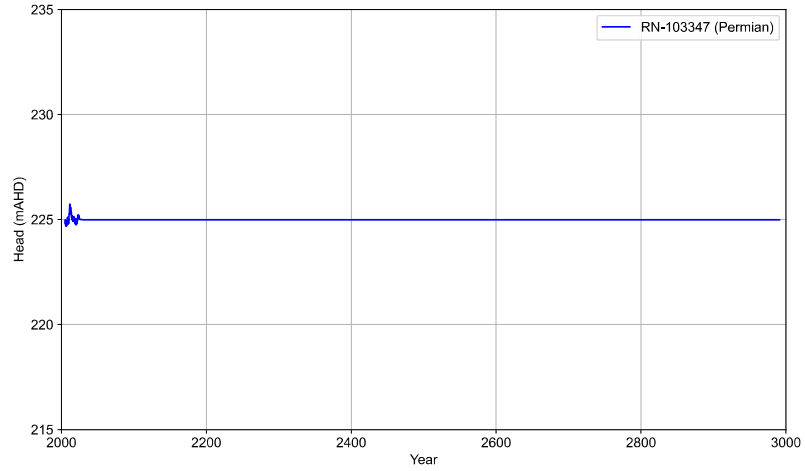

RN-62663 (Permian)
Head (mAHD)
Year
250
245
240
235
230
225
2000
2200
2400
2600
2800
3000

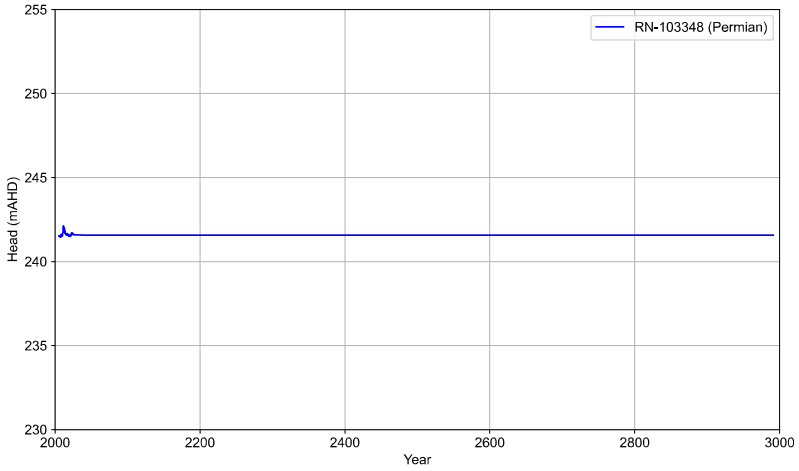

RN-84221 (Permian)
Head (mAHD)
Year
185
180
175
170
165
160
2000
2200
2400
2600
2800
3000

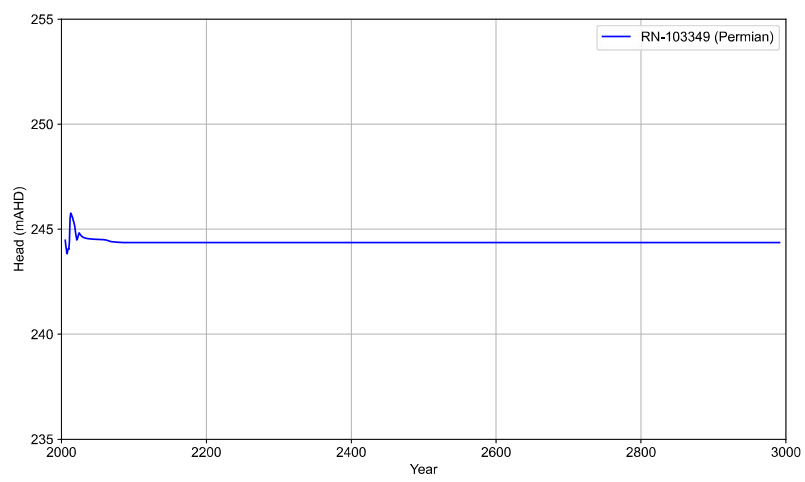

RN-90446 (Permian)
Head (mAHD)
Year
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200
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160
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2600
2800
3000

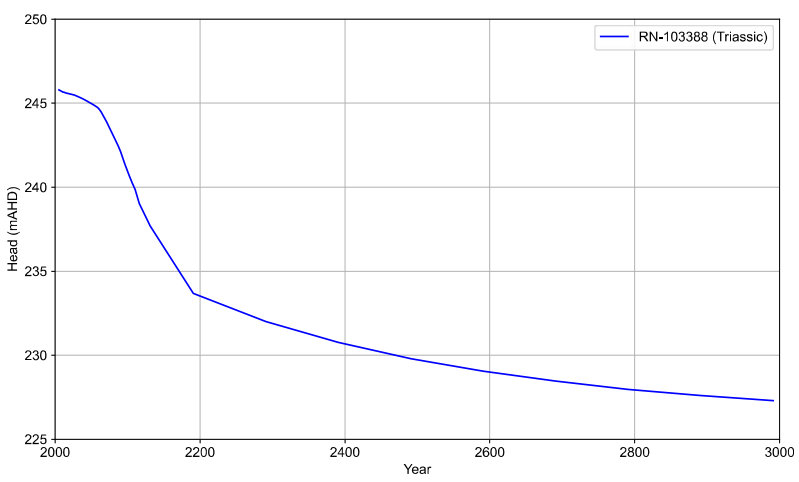

RN-90447 (Permian)
Head (mAHD)
Year
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220
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200
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2600
2800
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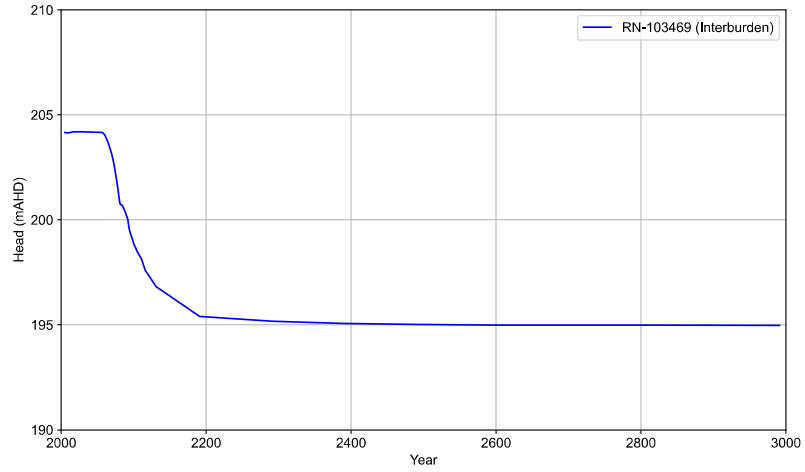

RN-103345 (Permian)
Head (mAHD)
Year
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310
305
300
2000
2200
2400
2600
2800
3000

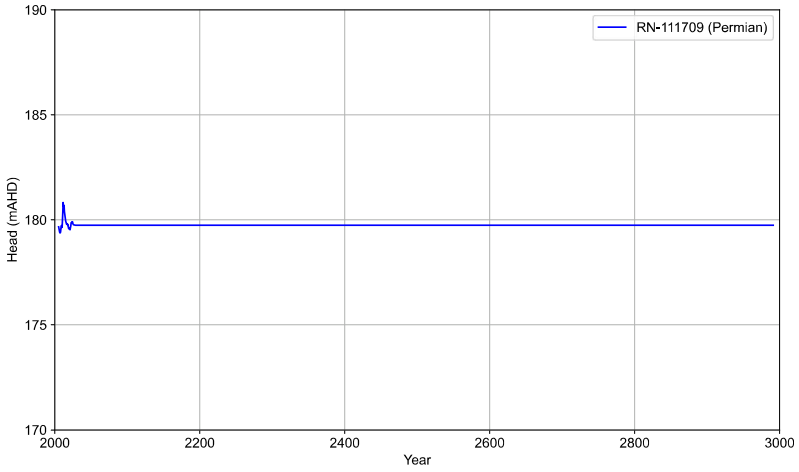

RN-103347 (Permian)
Head (mAHD)
Year
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230
225
220
215
2000
2200
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2800
3000

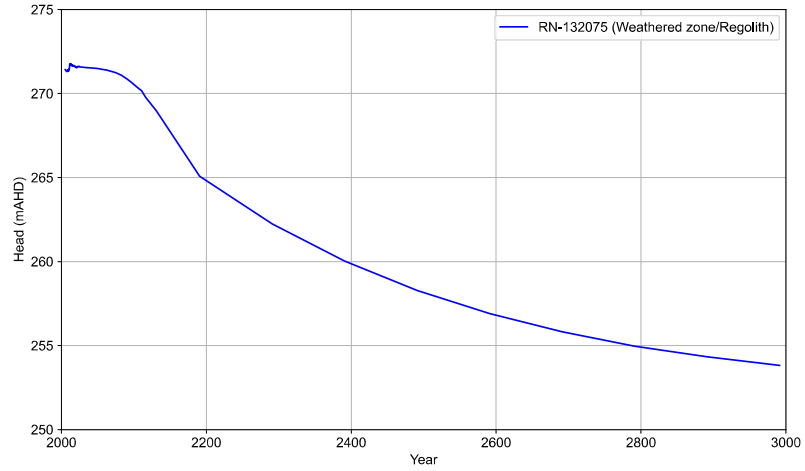

RN-103348 (Permian)
Head (mAHD)
Year
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2800
3000

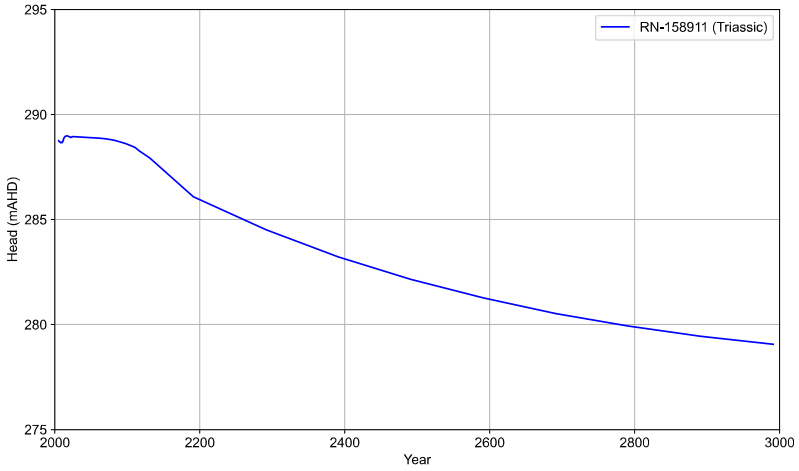

RN-103349 (Permian)
Head (mAHD)
Year
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250
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240
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2200
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2600
2800
3000

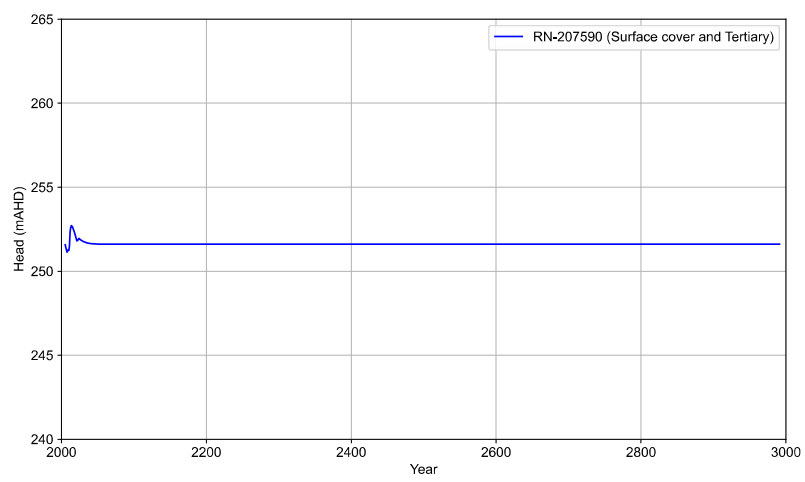

RN-103388 (Triassic)
Head (mAHD)
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240
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225
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2400
2600
2800
3000

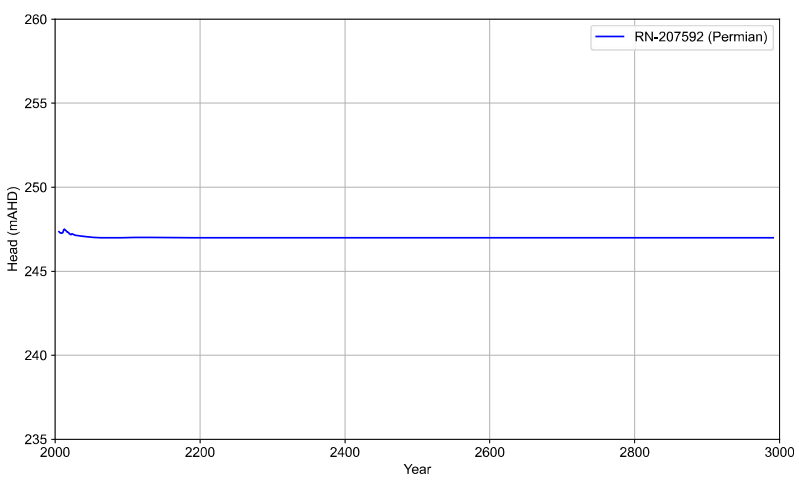

RN-103469 (Interburden)
Head (mAHD)
Year
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205
200
195
190
2000
2200
2400
2600
2800
3000

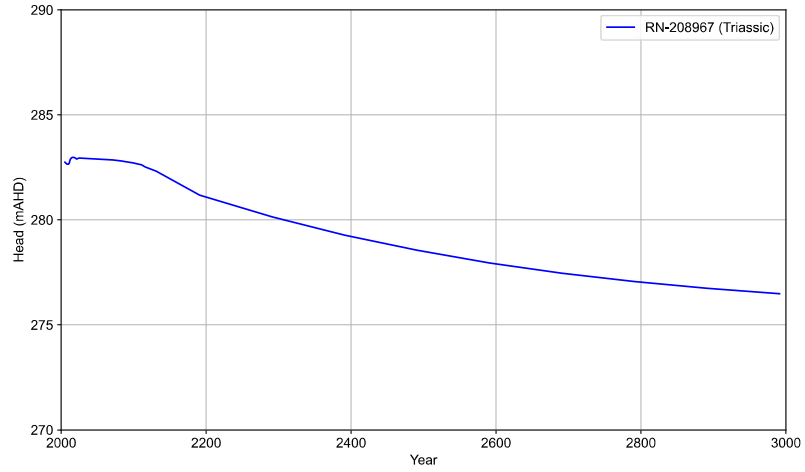

RN-111709 (Permian)
Head (mAHD)
Year
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185
180
175
170
2000
2200
2400
2600
2800
3000

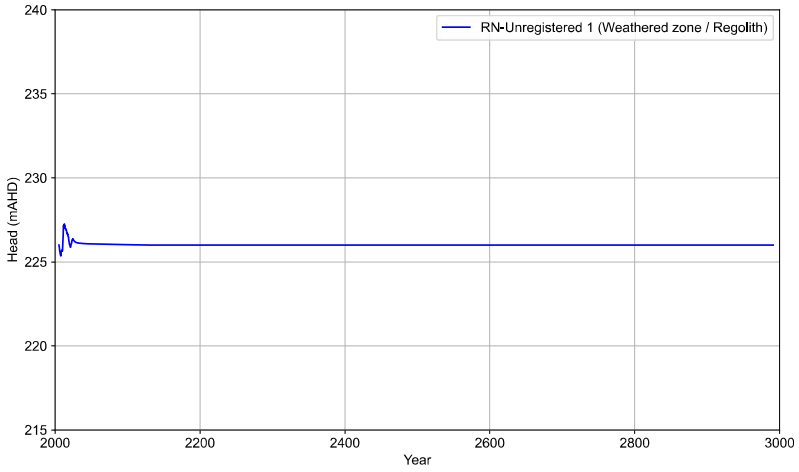

RN-132075 (Weathered zone/Regolith)
Head (mAHD)
Year
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270
265
260
255
250
2000
2200
2400
2600
2800
3000

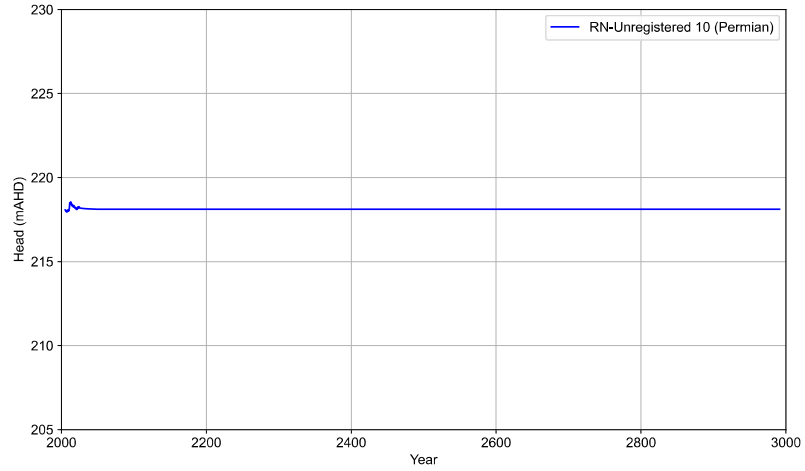

RN-158911 (Triassic)
Head (mAHD)
Year
295
290
285
280
275
2000
2200
2400
2600
2800
3000

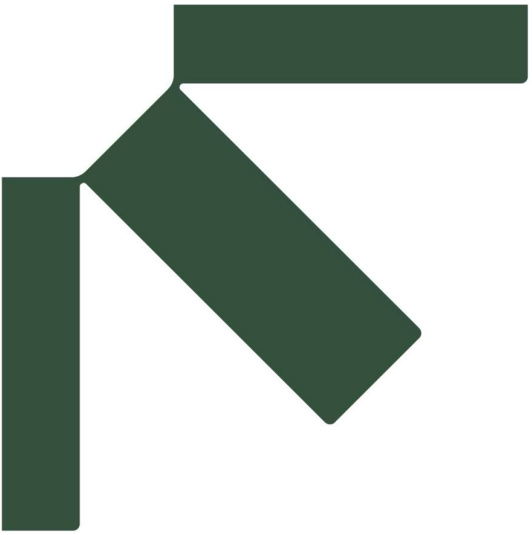

RN-207590 (Surface cover and Tertiary)
Head (mAHD)
Year
265
260
255
250
245
240
2000
2200
2400
2600
2800
3000


RN-207592 (Permian)
Head (mAHD)
Year
260
255
250
245
240
235
2000
2200
2400
2600
2800
3000


RN-208967 (Triassic)
Head (mAHD)
Year
290
285
280
275
270
2000
2200
2400
2600
2800
3000


RN-Unregistered 1 (Weathered zone / Regolith)
Head (mAHD)
Year
240
235
230
225
220
215
2000
2200
2400
2600
2800
3000


RN-Unregistered 10 (Permian)
Head (mAHD)
Year
230
225
220
215
210
205
2000
2200
2400
2600
2800
3000









MATERIAL CHARACTERISATION STUDY: BLACKWATER MINE

December 2025

Whitehaven Coal Limited

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Project Number: 1035.25e

Report Title: Material Characterisation Study: Blackwater Mine

Client: Whitehaven Coal Limited

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Rev 3 (revised)	E. Howard		11/12/2025

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1 INTRODUCTION

Whitehaven Coal Limited (Whitehaven) engaged Landloch to provide a material characterisation study of potential growth media at the Blackwater Mine (BWM). Specifically, the study is to 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 rehabilitated landforms need to be assessed for their suitability to support the vegetation required to meet the post-mining land use (PMLU).

1.1 Project description

BWM is a coal mine operated by Whitehaven, located to the south-west of the town of Blackwater in Queensland's Bowen Basin. Mining activities commenced in 1967 and consist of an open cut strip mine using dragline and truck and shovel fleets, and historic underground operations. Whitehaven acquired BWM from BHP Mitsubishi Alliance (BMA) in 2024.

1.2 Scope of work

The scope of work involved the following tasks:

1. Review previous soil, waste, and land assessments undertaken at BWM.
2. Review available published soils, geology, and land data within the region.
3. Conduct a 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.
4. Sample and analyse the topsoil stockpiles to gain data and fill the identified information gaps.
5. Collate existing and newly acquired soil and spoil characterisation data.
6. Interpret data, characterise materials, and prepare a report.

2 DESKTOP REVIEW

2.1 Climate

The mine is situated in Queensland's sub-tropical climate zone that is characterised by high summer temperatures, warm dry winters and a distinct wet and dry season.

The closest meteorological recording station is located at Emerald Airport (Site No. 035264). Data from this station indicate mean seasonal temperature ranges from 21.5°C to 34.7°C in summer and 9.1°C to 25.5°C in winter, with a summer dominant rainfall pattern averaging a total of 560 mm annually (Bureau of Meteorology, 2023). Rainfall events are often associated with short-lived, intense thunderstorms. These high intensity rainfall events produce high runoff rates and can create conditions conducive to erosion. The area is also susceptible to prolonged periods of drought.

2.2 Topography

The topography of BWM consists of gentle undulating plains with gravelly ridgelines and hills. Several ephemeral creeks and gullies drain to the Mackenzie River in the east and Comet River in the west, and both are part of the Fitzroy Basin catchment. Most of the terrain within these catchments is undulating, with minor steep areas in the upper catchments.

2.3 Regional geology

Geoscience Australia mapping of the mine identifies four major geological units. Descriptions of each geological unit are provided in Table 1.

Table 1: Geological units and descriptions for BWM (Geoscience Australia, 2023).

Geological unit	Description
Pwj – Permian	Rangal Coal Measures, Bandanna Formation, Baralaba Coal Measures. Sandstone, siltstone, mudstone, coal, tuff and conglomerate.
Pwt – Permian	Fair Hill Formation, Fort Cooper Coal Measures. Sandstone, conglomerate, mudstone, carbonaceous shale, coal and cherty tuff.
Pwg – Permian	Burngrove Formation. Siltstone, coal and sandstone.
Rr – Triassic	Rewan Group. Siltstone and sandstone.

2.4 Waste materials

The waste materials at BWM consist of overburden/interburden materials (spoil), coal rejects and tailings.

2.4.1 Spoil material

The spoil material at BWM consists of tertiary/weathered materials and fresh Permian materials.

Based on regional geology characteristics and spoil analysis data over the life of the mine, overburden/interburden geology at BWM can be broadly classified into:

- Tertiary/weathered materials: Cainozoic (Tertiary), ferruginous duricrusts and Quaternary calcareous sediments consisting of gravels, clays, sands, magnesite, laterite, and calcrete. These weathered materials are typically sodic, highly erodible, and prone to clay dispersion. They are known to have varying levels of salinity, but their main constraint is their high erosion risk.
- Fresh Permian materials: Permian sediments from the Blackwater Group, Rewan Group, and Emerald Formation to the south, consist of lithic sandstones, mudstones, pebble conglomerate, siltstones, shale, 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 have varying salinity, often reaching extremes where carbonaceous inclusions are present. Some carbonaceous strata are acidic or

acid forming. 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 or mudstones. The predominantly fresh, medium to coarse grained grey sandstone materials are less saline and offer greater benefits to rehabilitation.

Characterisation studies were undertaken by B.R. Emmerton (1998) and GTES (December 2007). Generally, spoil materials at BWM were found to be:

- Adequate in acid neutralising capacity (ANC) to limit the risk of acid formation;
- Strongly acidic (most Tertiary and some weathered Permian) to strongly alkaline (most Permian and some Tertiary);
- Sodic to strongly sodic and dispersive;
- Potentially highly saline; and
- Low in fertility.

2.4.2 Coal rejects

Coarse coal rejects are emplaced within the spoil materials and are not currently used as a rehabilitation resource. Further investigation may identify some to be beneficial for rehabilitation use due to their high organic carbon and coarse physical structure. Alternatively, strategies may be developed in the future for mixing them with spoil of high ANC to produce a combined material that is more suitable for use as a growth medium.

2.4.3 Tailings

Tailings are not characterised in this report as they are not currently considered a rehabilitation resource.

2.5 Soils

2.5.1 Regional soils mapping

Regional soils mapping of the mine identifies two broad soil groups across the project area (Department of Resources 2023) These include:

- MM7 – Vertosol or Dermosol; and
- Sl12 – Sodosols or Chromosols.

Relevant details of these soil groups are provided in Table 2.

Table 2: Summary details of regional soils.

Soil Landscape Code	Description	Associated Australian Soil Classification (ASC)
MM7	Dark and yellow friable earths with friable brown soils.	Vertosol, Dermosol
SI12	Complex range of soils occurring. Dominant soils are sandy to loamy duplex soils.	Sodosol, Chromosol

2.5.2 Recoverable soils

Several soil surveys have been undertaken across the mine area. These assessments include:

- CSR South Blackwater Mines: Evaluation of Soil Resources Existing Lease Areas, Report ENV-SBW-8604 (Environmental Services CSR Coal Division, 1986).
- CSR South Blackwater Mines: Mimosa Soils – An Assessment of Their Suitability for Use in Mine Site Rehabilitation, Report MEA-8801 (Mark Evans and Associates, 1988).
- Soil and Land Suitability Survey of the South Marshmead Lease Area MLA 70139 (Land Reclamation Services, 1997).
- Soil Stripping Survey, in Potential Disturbance Areas in Advance of Mining, Bonnie Doon Area, Blackwater Mine (B. R. Emmerton Pty. Ltd., 1999).
- Soils and Land Suitability Survey, BMA Blackwater Mine (Groundwork Environmental Management Services Pty. Ltd., 2001).
- Soils, Vegetation, and Land Suitability Survey, Kennedy Area, BMA Blackwater Mine (Groundwork Environmental Management Services Pty. Ltd., 2002).
- BMA Blackwater Mine: Assessment of Strategic Cropping Land (SKM, 2013).

Across all assessments a total of 26 soil landscape units (SLU) including variations, were identified within the mine area. A consolidated summary of all SLUs is provided in Table 3.

A soil map displaying broad ASC soil types for the BWM area is provided in Figure A9 (Appendix A). The data used to generate this map is a synthesis of soils data and mapping sourced from –

- existing soil assessments completed by the sources above;
- existing land systems information sourced from the QLD Globe online spatial data system (State of Queensland (Department of Resources), 2023); and
- a regional land resource assessment completed by (Burgess, 2003).

The map is Landloch's interpretation of the available soils information.

Table 3: Summary details of the SLUs developed in the previous soil assessments for BWM site.

SLU	Soil Details	Vegetation Description	Grazing Suitability Class
A1	Uniform brown clay or texture contrast soils on alluvial material in and adjacent to active drainage lines.	Mixed brigalow, yellowwood, poplar box and sandalwood. River red gum and Moreton Bay ash in creek channel.	2/3
B1	Gently undulating plains with cracking and non-cracking uniform clays and areas of gilgai developed from weathered non-quartzose Permian sedimentary rocks and Tertiary sediments.	Brigalow, blackbutt with associated bottle tree, poplar box and yellowwood.	2
B2	Undulating plains and rises of generally non-cracking clays with significant surface gravel.	Brigalow with blackbutt, ooline, sandalwood, Leichhardt bean, carissa. Includes areas of undulating ridges and stony Yapunyah.	3
B2v	Reddish brown texture contrast soils with thin sandy or loamy surface layer over well-structured alkaline clay subsoils and gravel.	Main vegetation is brigalow and associated species which include poplar box.	3/4
B3	Soils are reddish brown non-cracking clays often with a hard-setting sandy surface. Often quite shallow to weathered sediments.	Regrowth of brigalow, yellowwood, whitewood. Occasional poplar box. Ooline was present in original vegetation.	3
C1	Yellowish brown cracking and non-cracking uniform clays situated on gentle undulating plains with deep effective rooting depth.	Buffel grass with vegetation regrowth, consisting of mainly brigalow.	2
C1v	Yellowish brown cracking and non-cracking clays with reddish clays at depth situated on gentle undulating plains.	Buffel grass with vegetation regrowth.	5
C1gv	Brown to dark brown cracking and non-cracking uniform clays situated on gentle undulating plains with microrelief present in the form of gilgai and melon holes of varying sizes.	Whipstick brigalow, brigalow, and buffel grass.	5
D1	Grayish and minor dull yellow non-cracking clays situated on gentle undulating plains with deep effective rooting depth of approximately 45 – - 60 cm with soft lime and calcium carbonate present.	Buffel grass and brigalow.	4
D1gv	Grayish and minor dull yellow cracking and non-cracking uniform clays on gentle undulating plains with effective rooting depth of approximately 45 – 60 cm with normal gilgai present.	Whipstick brigalow, broom bush, buffel grass.	4
D2	Brownish black and black medium hard cracking clays situated on gentle undulating plains with deep effective rooting depth of approximately 70 – 80 cm with soft lime and calcium carbonate present.	Bauhinia, broom bush, yellowwood and minor brigalow.	3
D3	Light medium to medium clays overlying sand lenses near drainage, creek lines, and minor depressions.	Brigalow, whitewood.	4

SLU	Soil Details	Vegetation Description	Grazing Suitability Class
D4	Cracking light to light medium uniform brown clays over gentle undulating plains with no microrelief present.	Buffel grass.	3
D4sv	Cracking light to light medium uniform brown clays over gentle undulating plains with no microrelief present, however, is located on a slope greater than 3%.	Buffel grass.	3
D4rv	Cracking medium to light brown clays over gentle undulating plains within shallow depressions and overland runoff with gravels and cobbles present.	Buffel grass, acacia.	3
D5	Sandy clay loam overlying light brown clays along gently undulating plains.	Whipstick brigalow, Bauhinia, buffel grass.	3
E1	Shallow, rocky earths with some areas of gravelly and shallow texture contrast soils on the mesa margins.	Dominated with lancewood and areas of Dawson gum, poplar box or yapunyah	4/5
E2	Open ironbark with associated Acacias on hard-setting red sandy duplex of the tablelands.	Narrowleaf ironbark, yapunyah with associated acacias.	4
E3	Sandy texture contrast soils usually with hard-setting, gravelly surface and with erosive yellowish clay subsoils which are gravelly. Includes areas of shallow gravelly ridges and exposed bedrock.	Mixed scrub of poplar box, brigalow and sandalwood.	3
E4	Deeper loamy red earths on undulating plains.	Open silver leaf ironbark	2
E5	Loamy red and yellow earths usually underlain with lateritic gravel before 60 cm depth on uplands and mesa tops.	Mainly narrowleaf ironbark and bloodwood with a variety of wattles and other species.	3
F1	Alluvial creek areas with loam and silty loam soil profiles.	Brigalow, poplar box, bottle trees.	4
F2	Active alluvial plains with loams and clayey sand with soft to firm sandy surface.	Mount coolabah, minor brigalow.	3
F3	Brown silty clay loams on silty clays on gentle undulating plains. Calcium carbonate is present in subsoils.	Buffel grass.	2
R1	Rocky outcrop/hill	Mixed vegetation.	5
S1	Texture contrast and gradational soils situated on gentle undulating plains.	Buffel grass with very minor vegetation regrowth observed.	4

2.5.3 Stockpiled soils

Location and volume information on the current soil stockpiles was provided by the client. The approximate volume of available stockpiled material is 5,510,886 m^3 (in April 2023). Locations of topsoil stockpiles on BWM are presented in Figure 1.



Figure 1: Stockpiled topsoils across BWM.

2.6 Post-mining land use

Rehabilitation objectives for BWM are to create a safe, stable, non-polluting, and sustainable landscape with PMLUs in accordance with the EA:

- Cattle grazing ,
- Woodland habitat,
- Water storage, and
- Watercourse.

The predominant pre-mining land use was cattle grazing.

2.7 Revegetation methodology

Rehabilitation methods will vary between domains and PMLUs. Broadly, rehabilitation of disturbed areas will include:

- 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; and
- Expected growth media amelioration activities.

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

3 MATERIAL CHARACTERISATION METHODOLOGY

3.1 Materials

Soils and spoil materials were targeted for consideration as potential growth media. When considering the growth media at BWM, the quality of the stockpiled soil rather than the *in situ* topsoils is more representative of the material available for rehabilitation. Therefore, stockpiled soils were sampled by Landloch in a field program completed as part of this study. Spoil data collected by Landloch, as part of erodibility assessments for the Landform Design section of the PRC Plan, and data from previous studies were considered in the assessment of spoil materials as a potential growth media. All sampled

materials were characterised in terms of their basic chemical and physical properties. Any materials with the potential to be used at the surface of a rehabilitated landform as a primary growth media were subjected to additional fertility assessments.

3.2 Stockpiled soils

3.2.1 Field program details

The field program was undertaken between 6 and 22 March 2023. Substantial rainfall events occurred within the sampling period, and the wet site conditions hindered the sample collection.

3.2.2 Sampling plan and intensity

The soil sampling plan is listed in Table 4 and the stockpile sampling locations are shown in Figures A1–A4 (Appendix A).

The sample density adopted is consistent with a 'high (detailed)' intensity (McKenzie *et al.* 2008) and assumes soil will be placed at an average depth of 0.1 – 0.15 m at rehabilitation. Using these criteria, Table 5 shows the sample density for the stockpiles. Stockpile location details are provided in Table B1 (Appendix B).

Table 4: Soil stockpile sampling plan.

Stockpile ID	Area (m^2)	Number of Sampling Sites	Stockpile ID	Area (m^2)	Number of Sampling Sites
2	300	1	152	31,754	1
10	278	1	156	32,017	1
12	3,568	1	157	15,535	1
17	13,343	2	161	5,113	1
18	19,318	2	163	24,576	1
30	426	1	165	16,242	1
31	1,346	1	166	39,926	1
34	6,020	1	169	20,870	1
41	1,245	2	170	14,518	1
45	8,385	1	171	25,479	1
46	1,534	1	176	28,197	1
47	3,089	1	188	33,699	1
48	15,287	1	191	14,473	1
52	6,858	1	210	26,743	1
55	7,330	1	214	33,364	1
57	672	1	216	26,139	1
58	2,723	1	218	21,309	1
59	6,487	1	219	1,2041	1
61	87,246	2	221	2,281	1
62	4,244	1	222	2,592	1
67	73,177	1	228	56,528	2

Stockpile ID	Area (m^2)	Number of Sampling Sites	Stockpile ID	Area (m^2)	Number of Sampling Sites
68	1,986	1	231	58,701	2
69	9,891	1	232	9,377	1
70	8,488	1	248	7,784	1
71	10,837	1	250	7,849	1
72	2,526	1	251	7,697	1
73	25,601	1	253	2,771	1
81	14,463	1	255	18,995	1
82	42,205	1	256	16,144	1
86	77,119	1	259	7,187	1
93	14,274	1	267	14,781	1
102	10,616	1	268	147,397	3
103	17,646	1	270	12,941	1
108	14,767	1	275	2,399	1
111	1,566	1	278	827	1
123	9,953	1	283	8,481	1
124	36,029	1	284	14,379	1
126	11,565	1	285	7,802	1
130	23,621	1	291	77,725	2
138	742	1	296	12,305	1
145	11,257	1	315	10,534	1
148	68,544	1			
Total					92

Table 5: Sample density for soil stockpiles.

Soil Volume (m^3)	Reinstatement Coverage (ha)	Total Samples	Sampling Density	Sampling Density	Survey Scale
5,510,886	3,674*	368	1 sample/ 14,975 m^3	1 sample/ 10 ha	1:25,000

* Based on a replacement depth of 0.15m

3.2.3 Sample collection

Samples of materials were taken from test pits and the depth of excavation was to the base of the stockpile, or to the limit of excavation (~3–5 m). Samples were collected at depth intervals of 0.5–1.0 m (e.g. 0.5–1.0 m, 1.5–2.0 m, 2.5–3.0 m etc.). Brief details and descriptions of the collected materials were recorded in the field. Sampling included composite and discrete samples, where each composite sample was composed of materials from three discrete samples.

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) accreditations. Analysis of composite samples used a 'topsoil suite' to

characterise the soil nutrients and physico-chemical parameters of the materials. Laboratory analysis of discrete samples used a 'basic suite' of pH and salinity to indicate the heterogeneity (variability) within the stockpile and expose potential extreme values that may be masked in the testing of the composite samples. Laboratory analyses are described in Table 6.

Table 6: Laboratory analytical suites.

Analyses	Analysis Suite	
	Topsoil	Basic
pH_w and Electrical Conductivity ($EC_{1:5}$).	✓	✓
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, phosphorus buffer index (PBI), field texture	✓	
Dispersion potential	✓	
Total number of samples	92	276

3.3 Spoil materials

Geochemical and physical characterisation data for the spoil materials were collated from multiple assessments previously conducted for the project and from waste characterisation data collected as part of the PRC Plan preparation. Information sources included:

- Blackwater Mine, Soil and Spoil Assessment 1998 (B. R. Emmerton Pty Ltd, 1998);
- BMA Coal Blackwater Mine Overburden Quality (GTES Pty Ltd, December 2007)
- Targeted assessment of wastes and recommendations for rehabilitation at the former South Blackwater mine – BMA (Highlands Environmental , 2022);
- Environmental Geochemical Actions Related to the Draft Transitional Environmental Program (Terrenus Earth Sciences and RGS Environmental, 2010);
- Blackwater Coal Mine Rehabilitation Monitoring Report 2024 (Lyngco 2025a);
- Blackwater Coal Mine Woodland Habitat Rehabilitation Report BWM25 and BWM33 (Lyngco 2025b);
- Spoil data collected and analysed to inform Landloch's landform erodibility study as part of the PRC plan development; and
- Internal BWM spoil monitoring data.

4 FINDINGS

The two categories of materials available for rehabilitation were characterised as part of this assessment, and include:

1. Topsoil stockpiles; and
2. Spoil materials.

This section of the report provides information about these materials. Site location details are provided in Figures A1 – A4 (Appendix A) and in Table B1 (Appendix B). Stockpile description records are provided in Table B2–B3 and laboratory results are provided in Tables B4–B6 (Appendix B).

4.1 Topsoil stockpiles

A total of 368 samples were collected from 83 topsoil stockpiles. The 'topsoil suite' analysis was conducted on 92 samples and the 'basic suite' analysis was conducted on the remaining 276 samples.

Stockpiled topsoil for use in rehabilitation was categorised into three management groups:

1. Loam topsoil;
2. Clay topsoil; and
3. Gravelly clay topsoil.

A summary of key chemical and physical properties is presented in Table 7. Topsoil within each management group is detailed in the following sections.

Table 7: Summary of key chemical and physical properties for topsoils at BWM.

Analysis	Loam Topsoil	Clay Topsoil	Gravelly Clay Topsoil
Chemical Properties			
pH_w (pH Units)	Strongly acidic to slightly alkaline (4.8 – 7.7)	Moderate to strongly alkaline (8 – 9)	Moderate to strongly alkaline (8.1 – 9)
$EC_{1:5}$ (dS/m)	Low to moderate (0.1 – 0.3)	Low to moderate (0.2 – 0.5)	Low to moderate (0.2 – 0.7)
Chloride (mg/kg)	Very low (<65)	Very low to moderate (60 – 463)	Very low to high (58 – 642)
Exchangeable sodium percentage (ESP) (%)	Non-sodic (0.7 – 4.7)	Non-sodic to sodic (3.3 – 13.6)	Non-sodic to Strongly sodic (4.5 – 16.6)
Total N (mg/kg)	Low (680 – 1,450)	Low to moderate (760 – 1,930)	Low (840 – 1,420)
Available P (mg/kg)	Low to moderate (10 – 24)	Low to moderate (6 – 36)	Low to moderate (9 – 34)
Available K (mg/kg)	Low to moderate (124 – 232)	Low to moderate (115 – 270)	Low (125 – 180)
Total Organic Carbon (TOC) (%)	Low to high (0.8 – 1.9)	Low to high (0.9 – 2.1)	Low to moderate (0.9 – 1.6)
Effective Cation Exchange Capacity (ECEC) (meg/100g)	Low (3 – 10.4)	Moderate to high (13.7 – 27)	Low to high (12 – 28.2)
Ca/Mg (ratio)	Low Ca to balanced (2.5 – 4.6)	Low Ca (1.9 – 3.6)	Low Ca (1.4 – 3.4)

Analysis	Loam Topsoil	Clay Topsoil	Gravelly Clay Topsoil
Physical Properties			
Clay content (%)	10 – 30	>35	**>35**
Rock content (%)	10 – 30	<20	20 – 50
Dispersion (EAT)	Slightly dispersive to slaking (3b – 5)	Slightly dispersive to stable (3b – 7)	Slightly dispersive to slaking (3b – 5)
Permeability	Moderate	Low to Moderate	Moderate
Associated regional soil	SI12 (Sodosol)	MM7 (Dermososl/Vertosol)	MM7 (Dermososl/Vertosol)
Associated SLU	B2v, D5, E1, E2, E3, E4, E5, F1, F2, F3 and S1	A1, B1, B3, C1, C1v, C1gv, D1, D1gv, D2, D3, D4 and D4sv	B2, D4rv, E1 and R1

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

4.1.1 Loam topsoils

Loam soils account for 10% of samples assessed across BWM topsoil stockpiles and are scattered around the southern portion of the mine. These materials have a degree of variability, but due to the limited volumes present, have been grouped together to aid their management.

The soils are generally brown, reddish brown or greyish brown in colour, and have textures ranging from sandy loam to silty clay loam. Gravel content can be variable, ranging from 2–30% with gravel size generally being less than 60 mm in diameter. However, occasional cobbles and boulders can be present. The soils are susceptible to slaking and dispersion, thereby increasing the risk of erosion. Figures 2–5 illustrate representative loam topsoils and vegetation cover levels at BWM.

The main requirement for this soil is to ensure that its chemical fertility is managed to support vigorous vegetation growth in the initial stage of rehabilitation and maintain suitable levels of surface groundcover in the longer term. A suitable rock cladding can also be applied to reduce the erosion risk while vegetation establishes.

The loam soils would require different rehabilitation methods than the clay and gravelly clay soils. When this soil is to be used in rehabilitation, its chemical and physical limitations will need to be considered and managed.



Figure 2: Soil material excavated at sampling site 410973d.



Figure 3: Soil profile at sampling site 410950c.



Figure 4: Soil material at stockpile 410976.



Figure 5: Vegetation cover on topsoil stockpile 410950.

4.1.2 Clay topsoils

Clay topsoils account for 75% of samples assessed across BWM topsoil stockpiles and are distributed evenly throughout the mine area. Generally, these soils have relatively similar properties, but occasional minor inclusions of sands and loams were noted at varying stockpile depths. This is likely a result of topsoils from smaller texture contrast soil units being stripped simultaneously with the more dominant clays.

The soils are generally dark brown, reddish brown to brownish red or black in colour with occasional mottling and have textures ranging from light to medium heavy clay. Gravel content is generally less than 10% with gravel size being less than 60 mm in diameter. The soils often have vertic properties making them susceptible to slaking, thereby increasing the risk of erosion. Figures 6 – 9 illustrate representative clay topsoils and vegetation cover levels at BWM.

Stockpiled clay soils are often sodic and occasionally saline. In comparison to the other available soils, clay soils would be the preferred option for revegetation on sections of low erosion risk, such as low gradient areas on the tops of spoil dumps, where higher quality vegetation establishment and performance is required. If placed on steeper-gradient outer batter slopes, management of erosion risk during the period of vegetation establishment would be critical for rehabilitation success, and establishment of appropriate levels of persistent vegetation groundcover will be essential.

The main requirement for this soil is to ensure that its chemical fertility is managed to ensure vigorous vegetation growth in the initial stage of rehabilitation and maintain suitable levels of surface groundcover in the longer term. Any sodicity issues will also need to be addressed by incorporating gypsum prior to rehabilitation.



Figure 6: Soil material excavated at sampling site 410973d.



Figure 7: Soil profile at sampling site 410950c.



Figure 8: Soil material at stockpile 410976.



Figure 9: Vegetation cover on topsoil stockpile 410950.

4.1.3 Gravelly clay topsoils

Gravelly clay topsoils account for 15% of samples assessed across BWM topsoil stockpiles and are scattered around the southern portion of the mine. Generally, these soils have relatively similar properties to the clay topsoils, except for a higher gravel content. The soils are generally dark brown to reddish brown with some pale grey, yellow or red inclusions and occasional mottling. Textures range from light clay to medium heavy clay. The content of coarse fragments ranges from 20 – 50% with gravel and cobbles often present up to 200 mm in diameter. Like the clays, these soils are susceptible to slaking, thereby increasing the risk of erosion. However, this risk may be reduced by the higher rock content. Figures 10 – 13 illustrate representative clay topsoils and vegetation cover levels at BWM.

Stockpiled gravelly clay soils are often sodic and occasionally saline. In comparison to the other available soils, gravelly clay soils would be the preferred option for revegetation on batter slopes if the chemical limitations are addressed. Establishment of

appropriate levels of persistent vegetation groundcover will still be essential for long-term stability.

The main requirement for this soil is to ensure that its chemical fertility is managed to ensure vigorous vegetation growth in the initial stage of rehabilitation and maintain suitable levels of surface groundcover in the longer term. Any sodicity issues will also need to be addressed by incorporating gypsum prior to rehabilitation.



Figure 10: Soil material at stockpile 411080 (sampling site A).



Figure 11: Soil profile at stockpile 411080 (sampling site B).



Figure 12: Soil material at stockpile 410753.



Figure 13: Vegetation cover on topsoil stockpile 411080.

4.1.4 Stockpiles with limitations

Stockpiles 57, 166, 157, 191, 259 and 267 have elevated salts throughout the stockpile, particularly chloride-based salts. Groundcover observations (Table B2, Appendix B) indicate that high vegetation cover was present across the stockpiles at the time of sampling. The salts' concentrations are likely to affect seed germination rates, but once established, regional vegetation appears to be tolerant of salinity. If the stockpiled material is required for use as a growth medium, it is recommended that vegetation establishment initially favours species that tolerate saline soil conditions such as Rhodes grass (*Chloris gayana*).

4.2 Spoil materials

From the previous assessments detailed in Section 3.3, spoil material characteristics were found to be heterogeneous within each spoil type and across sampling areas. For this reason, spoil materials are categorised into three management groups that have broad similarities:

- Fresh Permian materials;
- Weathered Permian materials; and
- Tertiary materials.

A summary of key chemical and physical properties is presented in Table 8. Each spoil management group is described in further detail in the following sections.

Table 8: Summary of key chemical and physical properties for spoils at BWM.

Analysis	Fresh Permian	Weathered Permian	Tertiary
Chemical Properties			
pH_w	Strongly alkaline (8.4 – 9.8, but can be highly acidic)	Strongly acidic to strongly alkaline (5 – 9.4, can be <5)	Strongly acidic to strongly alkaline (5 – 9.4, more often strongly acidic)
$EC_{1:5}$ (dS/m)	Low to extreme (0.19 – 2.3)	Low to extreme (0.1 – 3.3)	Low to extreme (0.35 – 2.2)
Estimated Acid Neutralising Capacity (ANC)*	Reasonable	Reasonable	N/A
ECEC	Low – adequate	Low – adequate	Adequate
ESP (%)	Non–sodic to strongly sodic (3 – 30)	Non–sodic to strongly sodic (3 – 33)	Sodic to strongly sodic (14 – 30)
Ca/Mg (ratio)	Very low to low Ca, (0.3 – 1.9)	Very low to low Ca (0.3 – 1.4)	Very low to low Ca (0.4 – 2.1)
Fertility	Low to moderate	Low to moderate	Low
Physical Properties			
Clay content (%)	20 – 40	15 – 45	>35
Rock content (%)	Up to 74%	30 – 60%	10 – 20
Permeability	Moderate	Moderate	Low
Dispersion potential	Moderate to high	Moderate to high	High to extreme
Dispersion risk	Moderate to high	Moderate to high	Very high

* ANC estimates are taken from the *BMA Coal Blackwater Mine Overburden Quality* (GTES Pty Ltd, 2007) assessment.

4.2.1 Fresh Permian materials

Permian materials at BWM can vary depending on the degree of weathered inclusions. Generally, fresh Permian materials are rocky and consist primarily of sandstone and siltstone, with clay content in the fine fraction ranging from 20–40%, and the coarse rock fraction being up to 75% of the mass of the material. Water holding capacity and permeability are variable and depend on the clay content along with the volume and composition of rock present. It is generally grey in colour but may vary to pale brown

after some weathering. The material ranges from moderately to highly dispersive but this can occasionally be masked by the presence of saline lenses. The material is considered to have reasonable ANC potential. Figures 14 and 15 are representative of fresh Permian spoil at BWM.

Of the spoil management groups, fresh Permian materials are considered most suitable for placement close to the final rehabilitated surface for use as a secondary growth media. Due to the heterogeneity, discrete testing should be conducted prior to rehabilitation. Competent (durable), fresh Permian sandstone has potential to be used as a rock armour to greatly increase batter slope resistance to erosion and to stabilise steeper areas.



Figure 14: Fresh Permian sandstone material present at the mine. Large-sized competent rock is present throughout the stockpile.



Figure 15: Rocky fresh Permian material with weathered Permian inclusion that was sampled during erodibility studies.

4.2.2 Weathered Permian materials

Weathered Permian materials are the dominant spoil material at BWM and are highly variable in their characteristics depending on the strata location, presence of carbonaceous inclusions and degree of weathering. Generally, weathered Permian materials have a lower and finer rock content than fresh Permian. The rock consists primarily of fragile mudstone and sandstone, with clay content in the fine fraction ranging from 15–45% and the coarse rock fraction being 30–60% of the mass of the material. Similar to fresh Permian, the water holding capacity and permeability are variable and depend on the clay content along with the volume and composition of rock present. Data obtained from monitoring programs indicates this material can be susceptible to capillary rise of salts if infiltration is limited (GTES 2007). It is generally pale brown to brown in colour, but colour can vary. The material ranges from moderately to highly dispersive but this can occasionally be masked by the presence of salts. It is considered to have reasonable ANC potential. Figures 16 and 17 are representative of fresh Permian spoil at BWM.

Weathered Permian materials are considered suitable as a secondary growth media but should be capped with a quality topsoil material to prevent exposure to the final rehabilitated surface. If exposed, this material will be susceptible to erosion due to the tendency to rapidly weather and disperse. For material with elevated salts, it is preferable to mix with more permeable materials to promote infiltration and leaching of salts. If more permeable material isn't available, placement should be limited to slopes less than 10%. Due to the heterogeneity, discrete testing should be conducted prior to rehabilitation.



Figure 16: Weathered Permian pre-strip material present at the mine. Weathered and partially weathered rock is present across the area.



Figure 17: Stockpiled weathered Permian material present at the mine. The material is coarsely grained with variable weathering throughout the profile.

4.2.3 Tertiary materials

Tertiary materials are a highly weathered material containing small portions of fragile (low durability) rock. Generally, it has a clay content above 35%, resulting in moderate to high water holding capacity. It is typically pale orange in colour. The materials are often highly saline and strongly sodic, making it prone to a hard setting surface (Figure 18). Compared to Permian materials, the weathered Tertiary material is more susceptible to slaking and dispersion.

Placement of this material close to the final rehabilitated surface is not recommended on steeper gradient slopes (>15%) due to its susceptibility to erosion (including tunnel erosion) and potential toxicities to plant growth. However, targeted testing may identify suitable Tertiary materials that could potentially be used to form a marginal secondary growth medium where required. Monitoring data from lower gradient (≤15%) slopes show that tertiary materials can be used as secondary growth media to support grazing and woodland PMLUs (Lyngco 2025a, 2025b).

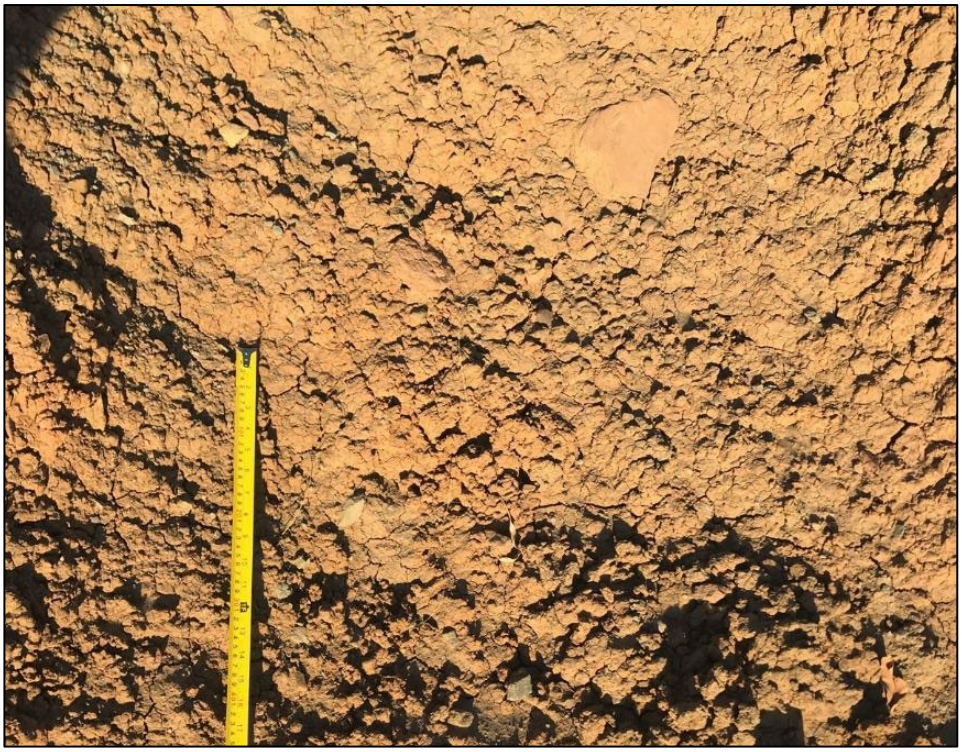


Figure 18: Hard setting Tertiary spoil stockpiled at the mine.

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 placed over the rehabilitated area. It can be applied at 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 subsoils or spoil materials, ameliorated to a standard suitable to support sustainable plant growth. It is typically higher in organic matter and macro- and micro-nutrients and has low to negligible limitations to plant growth. Its primary purpose is to provide nutrients and a stable surface for vegetation establishment.

If sufficient suitable primary growth media is not available, an alternative growth media may be derived by amelioration of suitable subsoils or spoil materials. Amelioration products and application rates for the primary growth media should be assessed by an appropriately qualified person prior to rehabilitation, and to also ensure the desired PMLU and vegetation is considered. Amelioration must address both the physical and chemical suitability of the material.

5.2 Secondary growth media

Secondary growth media infers the ability of materials to be used as a subsoil or subsoil surrogate. Typically, secondary growth media layers are capped with primary growth media. In the absence of subsoil, it may be a spoil material, or an intermediate layer of ameliorated spoil situated above un-ameliorated spoil material.

The main purpose of the secondary growth medium is to increase the soil water storage capacity in the root zone, and/or 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.

The suitability of materials as primary or secondary growth media is presented with recommendations in Table 9.

Table 9: Recommended fertiliser and ameliorant treatments for materials and growth media suitability classification.

Material	Limitations	Amendments	Suitability Class	
			Primary (1)	Secondary (2)
Loam topsoil	• Sometimes strongly acidic • Low ability to retain nutrients • Low N • Often low P, K and TOC • Sometimes low Ca	• Fertiliser and/or compost rates are to be determined by an appropriately qualified person prior to individual stockpiles being used in rehabilitation.	1A	2A
Clay topsoil	• Sometimes strongly alkaline • Often sodic and sometimes dispersive • Susceptible to slaking • Sometimes low N, P, K, TOC and Ca	• Gypsum: due to heterogeneity between stockpiles, rates should be calculated for individual stockpile prior to use. • Fertiliser and/or compost rates are to be determined by an appropriately qualified person prior to individual stockpiles being used in rehabilitation	1B	2A
Gravelly clay topsoil	• Sometimes strongly alkaline • Sometimes high chloride • Often sodic and sometimes dispersive • Susceptible to slaking • Low N, K and Ca • Sometimes low P and TOC	• Gypsum: due to heterogeneity between stockpiles, rates should be calculated for individual stockpile prior to use. • Fertiliser and/or compost rates are to be determined by an appropriately qualified person prior to individual stockpiles being used in rehabilitation.	1B	2A
Fresh Permian materials	• Strongly alkaline • Sometimes high salinity • Often strongly sodic and dispersive • Rock content up to 75% • Often low fertility and ability to retain nutrients	• Gypsum: due to heterogeneity between spoil samples, rates should be calculated for broad spoil areas after placement. • Bury all saline material to a depth greater than 2 m below the surface. • If to be used as a primary growth media further assessment by an appropriately qualified person is required to determine amelioration required.	1C	2B

Material	Limitations	Amendments	Suitability Class	
			Primary (1)	Secondary (2)
Weathered Permian materials	• Often strongly acidic or strongly alkaline • Sometimes high salinity and potential for capillary rise • Often strongly sodic and dispersive • Often low fertility and ability to retain nutrients • High variability in physical and chemical characteristics	• Gypsum: due to heterogeneity between spoil samples, rates should be calculated for broad spoil areas after placement. • Chemical and physical variation: due to heterogeneity within the material, additional sampling should be completed prior to use in rehabilitation. • Bury all saline material to a depth greater than 2 m below the surface.	1D	2B/C

Tertiary materials	• Often strongly acidic or strongly alkaline
	• Sometimes high salinity
	• Sodic or strongly sodic and dispersive
	• Low permeability
	• Low fertility
		• Most material is not suitable for placement in the upper soil profile, especially on steeper gradients (>15%).
		• Where no alternative is available:
		  ○ Mix with competent rock.
		  ○ Gypsum: due to heterogeneity between spoil samples, rates should be calculated for broad spoil areas after placement for rehabilitation.
		• Bury all saline material to a depth greater than 2 m below the surface.
			1D	2C

Notes: Class A – Good Quality: Negligible limitations to plant growth; Class B – Fair Quality: Minor limitations to plant growth; Class C – Marginal Quality: Moderate limitations to plant growth; and Class D – Not Suitable: Severe limitations to plant growth.

5.4 Fertiliser and ameliorants

Fertiliser and amelioration rates for spoil materials are dependent on the intended PMLU for each rehabilitated area. For example, cattle grazing requires the generation of biomass and as such, nitrogen and phosphorus-based amendments would be recommended for these areas. As a guide to amelioration application for grazing, PMLU should aim to provide:

- Available 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; and
- Gypsum to reduce sodicity and 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 Fertiliser

A balanced NPK fertiliser such as Crop King 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).

Accurate application rates and fertiliser types based on the required nutrients should be determined by an appropriately qualified person prior to use in rehabilitation.

Fertiliser and mulch/compost should be applied at seeding. It can be broadcast with a spreader or applied hydraulically or pneumatically. Spreaders are typically suitable for slopes with gradients <35%, and hydraulic or pneumatic applications will be required for steeper slopes.

5.4.2 Gypsum

Gypsum application is recommended for sodic/dispersive materials or where calcium is low. It should be applied in a manner that allows for as thorough mixing as is practicable of the surface materials. Gypsum should be applied during the soil preparation stages prior to seeding and fertilising.

Depth of sodicity amelioration depends on erosion risk/land gradient. Generally, for slopes with gradients less than ~35%, incorporate gypsum into the upper 0.3 m depth of sodic materials.

Considering the annual rainfall at BWM is approximately 560 mm, it is expected that (as a 'rule of thumb') gypsum will dissolve at a rate of 0.5–1.0 t/ha/y. Hence, there is benefit in applying gypsum at the time materials are recovered (i.e. stripped) or as soon as is practical in the rehabilitation program to allow the gypsum to be as effective as possible.

6 SUMMARY AND RECOMMENDATIONS

This material characterisation report describes and characterises the materials identified on-site for use in rehabilitation using the topsoil stockpile assessment, erodibility studies, previous soil and spoil assessments, and other BWM project-related documents.

6.1 Soil stockpiles

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

The main limitations of the stockpiled soils for use in rehabilitation are low fertility and for clay dominated topsoil, sodicity.

Chemical fertility of the stockpiled soils is often low. A balanced NPK fertiliser or compost should be applied during rehabilitation to provide a starter source of nutrients for initial vegetation growth. Subsequent applications of fertiliser, particularly nitrogen, may be required to maintain adequate fertility levels and ensure vegetation is established in the long-term.

Amelioration of sodicity requires the thorough incorporation of gypsum. Due to the high degree of heterogeneity of measured sodicity within stockpiles, gypsum rates should be calculated for individual stockpiles prior to use in rehabilitation.

Amelioration products and application rates should be assessed by an appropriately qualified person prior to use for rehabilitation and to complement the desired PMLU.

6.2 Spoil materials

Generally, Permian materials, both fresh and weathered, have the highest potential to be used as secondary growth media through varying degrees of amelioration. Where possible, placement of Tertiary materials in the upper layer of the landform should be avoided.

Where primary growth media availability is limited, a topsoil/fresh Permian spoil mix may be adopted to form a primary growth media with potential to support a woodland PMLU, provided adequate amelioration is completed to negate any limiting properties of the spoil. If adopted, the chemical and physical properties and the overall viability of the proposed material should be assessed by a suitably qualified person before being applied to the broader rehabilitation.

All spoils with elevated salts will need to be managed to prevent capillary rise and subsequent accumulation of salts in the primary growth media. Maximising infiltration by limiting slope gradient or mixing with a more permeable material are considered the most practical approaches.

Due to the high degree of heterogeneity in the spoil materials, the summarised laboratory data should only be considered a guide to their suitability. Targeted sampling of spoil

materials planned for use in the upper soil profile (i.e. primary or secondary growth media) should be conducted prior to rehabilitation.

Chemical fertility of all spoil materials is low and would benefit from an application of a balanced NPK fertiliser or compost.

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 primary PMLUs for rehabilitated areas of cattle grazing and woodland habitat. It is recommended that the growth media for each rehabilitation campaign be assessed by an appropriately qualified person prior to rehabilitation, to identify the required ameliorants and fertilisers.

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APPENDIX A: MAPS AND FIGURES

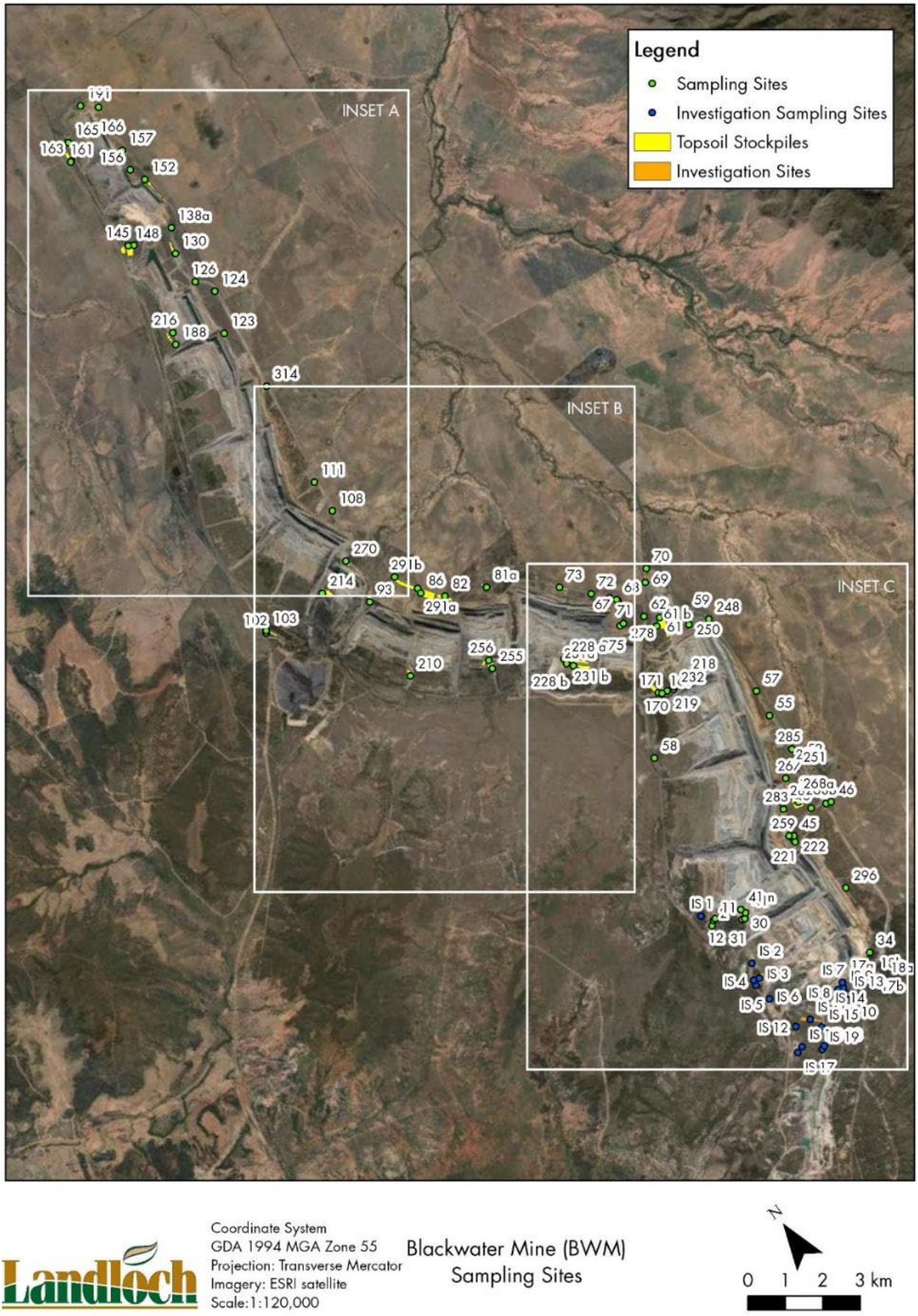


Figure A1: BWM topsoil stockpile sampling locations.



Figure A2: BWM soil stockpile sampling locations in the northern mine area (Inset A).



Figure A3: BWM soil stockpile sampling locations in the middle mine area (Insert B).



Figure A4: BWM soil stockpile sampling locations in the southern mine area (Insert C).

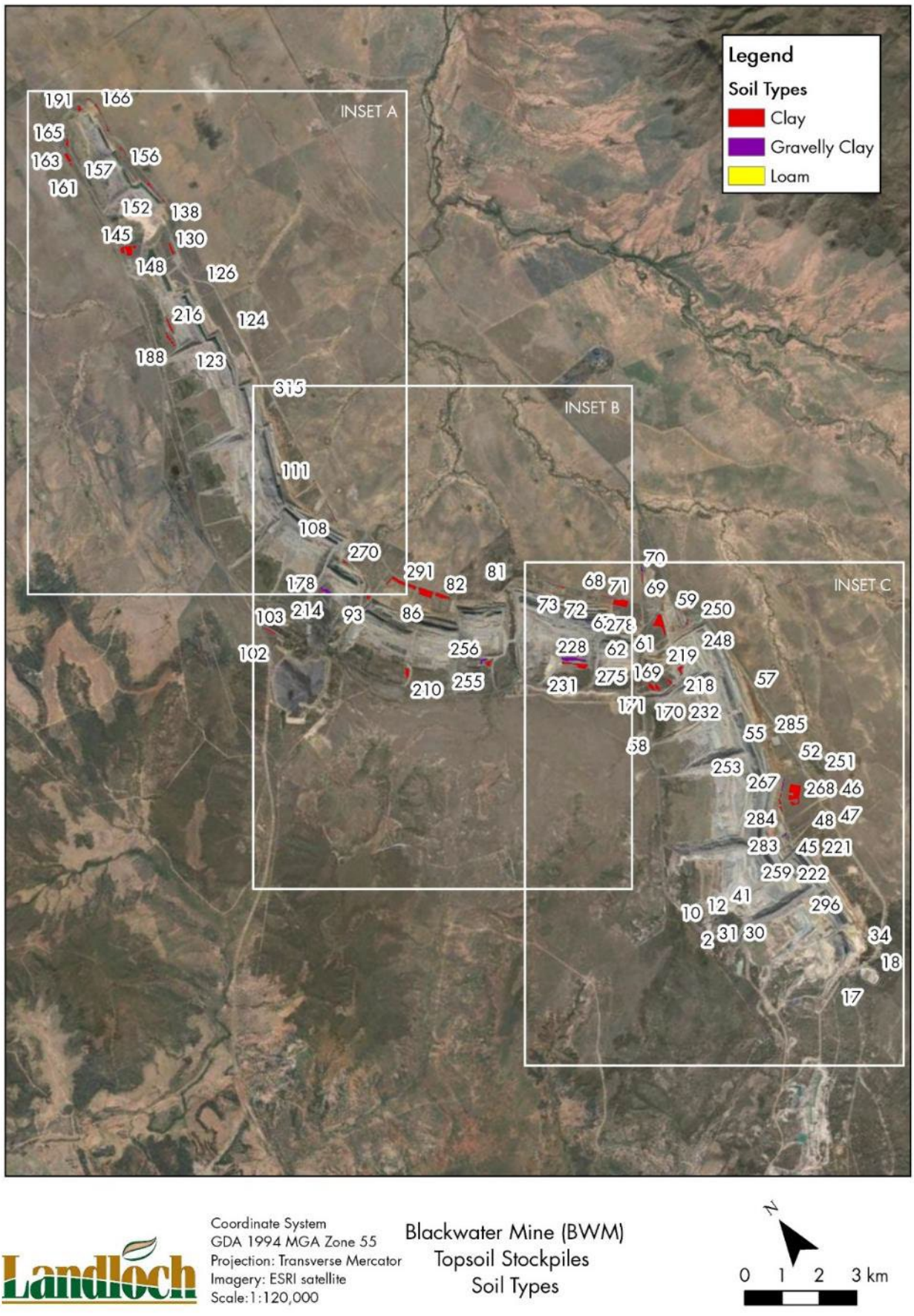


Figure A5: Distribution of stockpiled topsoil materials and stockpile identities at BWM.



Figure A6: Distribution of stockpiled soil materials and stockpile identities at BWM (Insert A).

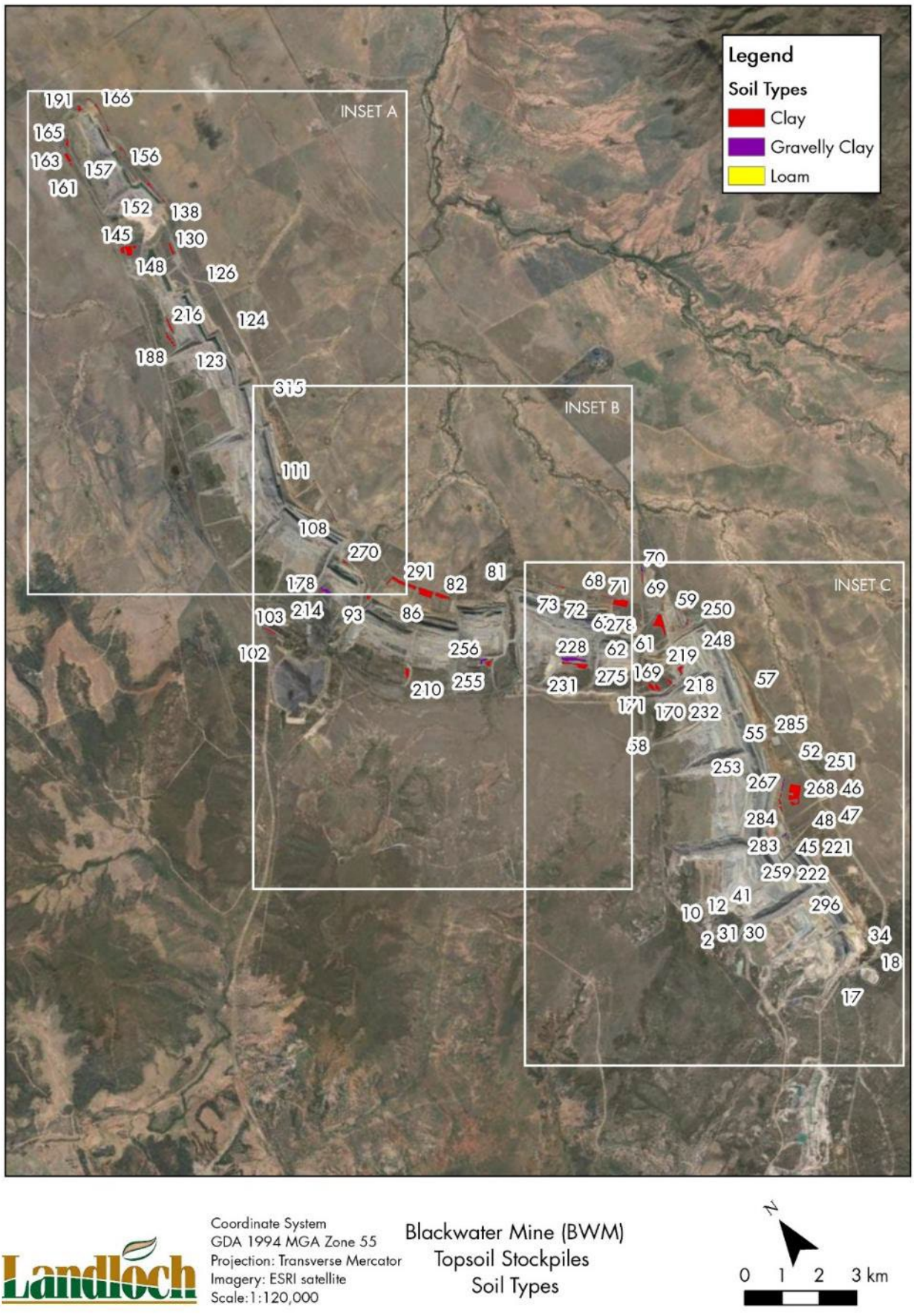


Figure A7: Distribution of stockpiled soil materials and stockpile identities at BWM (Insert B).

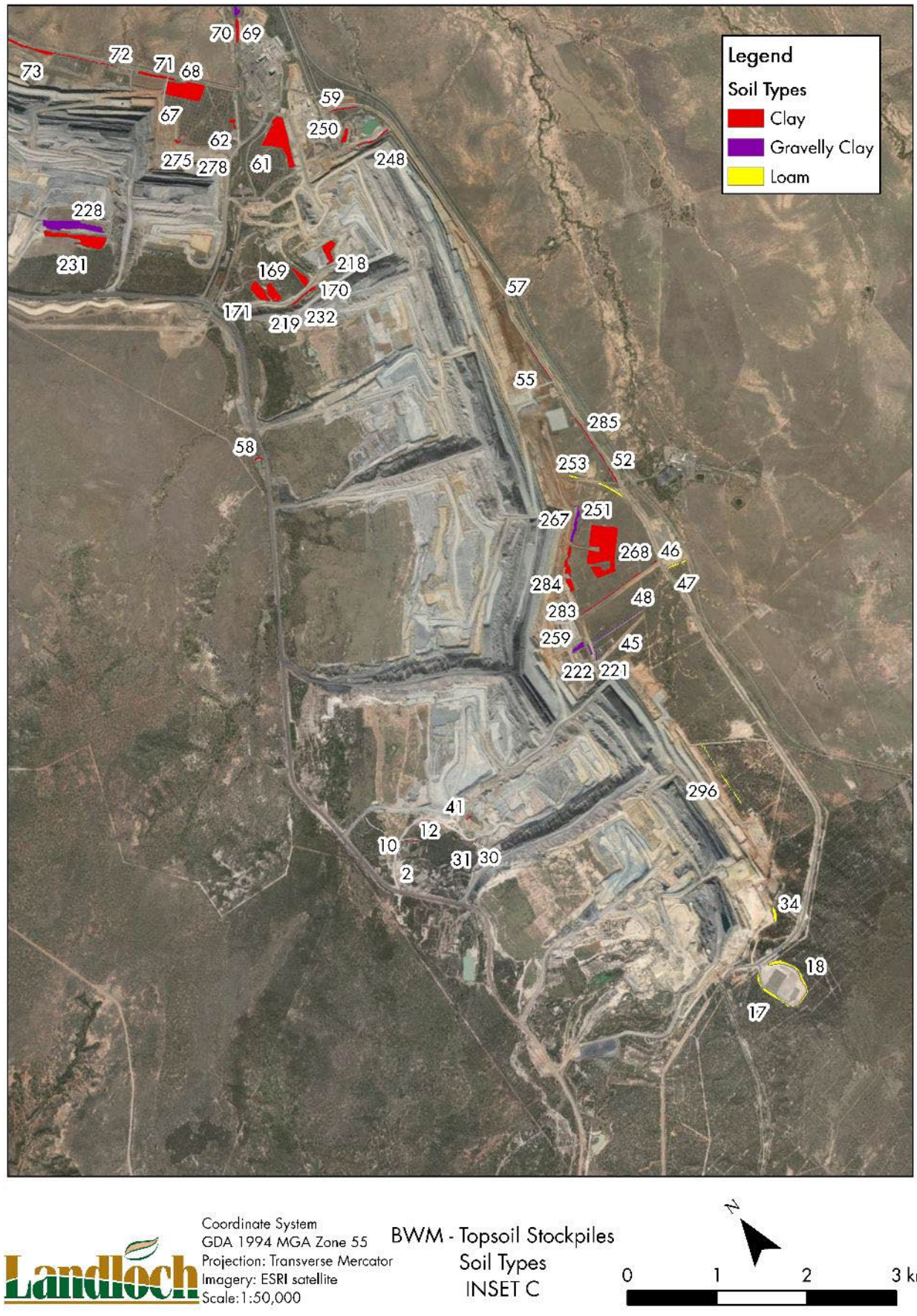


Figure A8: Distribution of stockpiled soil materials and stockpile identities at BWM (Insert C).

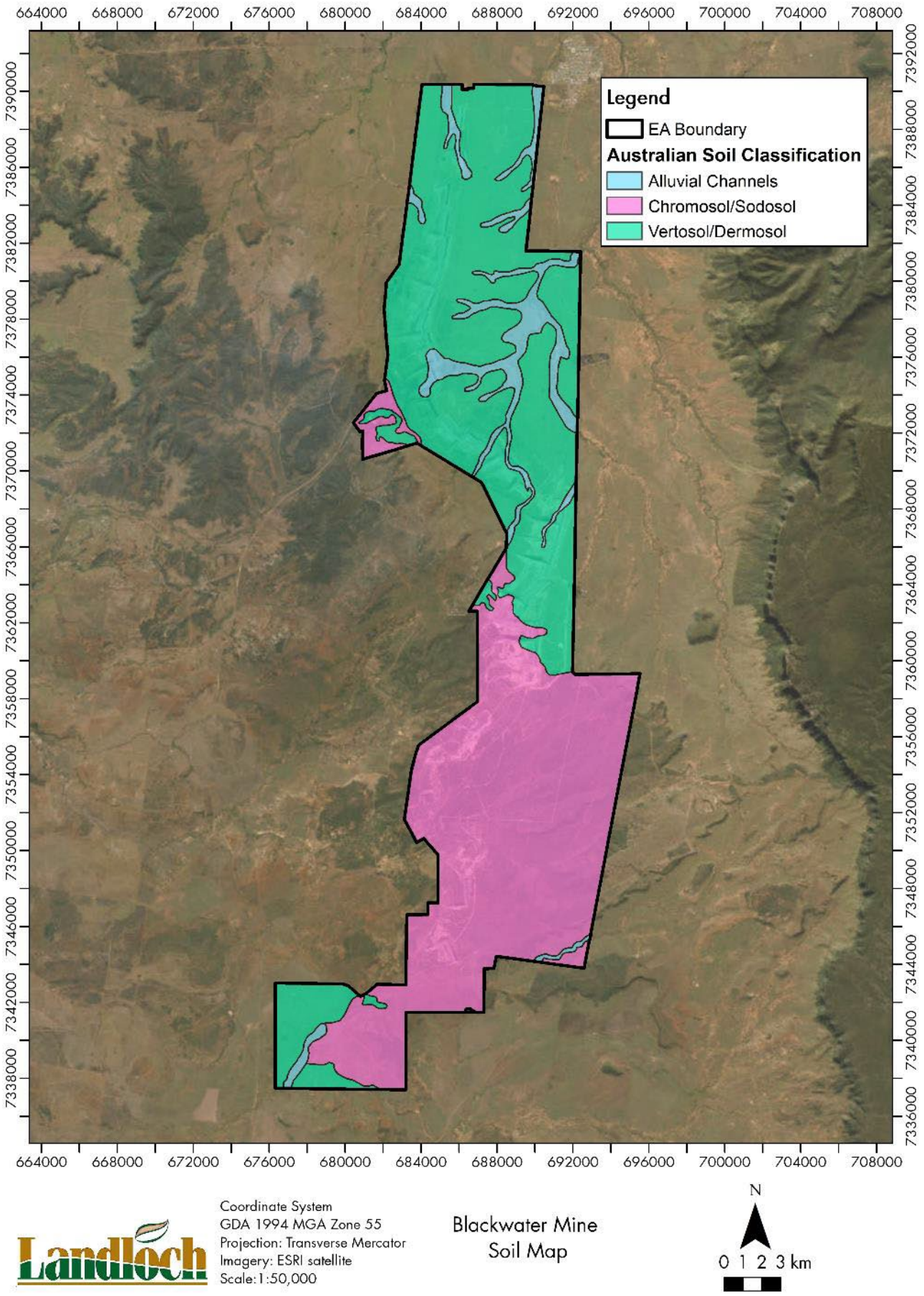


Figure A9: ASC soil mapping synthesised from existing soil assessments.

APPENDIX B: DATA TABLES

Table B1: Sampling site locations.

Site ID	Type	Latitude	Longitude
166	Topsoil stockpile	-23.59802818	148.8278925
191	Topsoil stockpile	-23.59525871	148.8241753
165	Topsoil stockpile	-23.60091782	148.8161545
163	Topsoil stockpile	-23.6050148	148.8141073
161	Topsoil stockpile	-23.60514069	148.8138643
156	Topsoil stockpile	-23.61475754	148.8255319
157	Topsoil stockpile	-23.60980225	148.8267107
152	Topsoil stockpile	-23.61862755	148.8272481
130	Topsoil stockpile	-23.63753891	148.822967
126	Topsoil stockpile	-23.64583206	148.8230632
124	Topsoil stockpile	-23.65038681	148.8259282
123	Topsoil stockpile	-23.66003227	148.821764
138a	Topsoil stockpile	-23.63183784	148.8258795
314	Topsoil stockpile	-23.67629051	148.8231125
111	Topsoil stockpile	-23.70185661	148.8192894
108	Topsoil stockpile	-23.70999146	148.8189732
270	Topsoil stockpile	-23.72184181	148.8144607
93	Topsoil stockpile	-23.73320198	148.8136208
291a	Topsoil stockpile	-23.73703957	148.8260059
291b	Topsoil stockpile	-23.73162842	148.822675
86	Topsoil stockpile	-23.73835182	148.8259969
81a	Topsoil stockpile	-23.74608803	148.8410505
82	Topsoil stockpile	-23.74221611	148.8307706
73	Topsoil stockpile	-23.75597	148.8568182
67	Topsoil stockpile	-23.76663017	148.8674779
71	Topsoil stockpile	-23.76489449	148.8660728
69	Topsoil stockpile	-23.76664925	148.876113
61	Topsoil stockpile	-23.77558899	148.8739726
61 b	Topsoil stockpile	-23.77689362	148.8720813
296	Topsoil stockpile	-23.85461235	148.8744966
48	Topsoil stockpile	-23.83402252	148.8787271
284	Topsoil stockpile	-23.82904434	148.8732071
268a	Topsoil stockpile	-23.82949066	148.8771785
268b	Topsoil stockpile	-23.83106232	148.8767802
256	Topsoil stockpile	-23.76095772	148.8307947
17a	Topsoil stockpile	-23.87491608	148.8650623
18a	Topsoil stockpile	-23.87794495	148.8689974
255	Topsoil stockpile	-23.76305962	148.830326
210	Topsoil stockpile	-23.75341988	148.8115358
102	Topsoil stockpile	-23.72528839	148.7867002
103	Topsoil stockpile	-23.72486877	148.7870308
214	Topsoil stockpile	-23.72504425	148.8046287
216	Topsoil stockpile	-23.65295792	148.8107479
188	Topsoil stockpile	-23.65569878	148.8096411

Site ID	Type	Latitude	Longitude
145	Topsoil stockpile	-23.63024521	148.8152339
148	Topsoil stockpile	-23.6295948	148.8138974
228 a	Topsoil stockpile	-23.7708931	148.8472299
228 b	Topsoil stockpile	-23.77192116	148.8473667
231 b	Topsoil stockpile	-23.77213669	148.8470965
70	Topsoil stockpile	-23.76402855	148.8783613
275	Topsoil stockpile	-23.77187538	148.8642506
278	Topsoil stockpile	-23.77187729	148.8652825
68	Topsoil stockpile	-23.76619911	148.8673287
72	Topsoil stockpile	-23.76157379	148.8626784
232	Topsoil stockpile	-23.79174614	148.8664496
62	Topsoil stockpile	-23.77323532	148.8707824
250	Topsoil stockpile	-23.78092384	148.8793256
248	Topsoil stockpile	-23.78253937	148.8843923
57	Topsoil stockpile	-23.80333519	148.8841401
55	Topsoil stockpile	-23.80994987	148.883361
285	Topsoil stockpile	-23.81966019	148.8832252
52	Topsoil stockpile	-23.82315636	148.8831367
47	Topsoil stockpile	-23.83518791	148.882622
251	Topsoil stockpile	-23.8242321	148.8810901
253	Topsoil stockpile	-23.82267189	148.8798111
267	Topsoil stockpile	-23.82462883	148.8776103
268c	Topsoil stockpile	-23.82899857	148.8765844
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221	Topsoil stockpile	-23.83710098	148.8702594
45	Topsoil stockpile	-23.83720398	148.8708987
222	Topsoil stockpile	-23.83860779	148.8702701
59	Topsoil stockpile	-23.77819061	148.8806264
218	Topsoil stockpile	-23.79071045	148.8708397
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219	Topsoil stockpile	-23.79116058	148.8648383
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169	Topsoil stockpile	-23.79097176	148.8633755
58	Topsoil stockpile	-23.80288124	148.8522071
2	Topsoil stockpile	-23.84400177	148.8399913
11	Topsoil stockpile	-23.84314728	148.841079
12	Topsoil stockpile	-23.84300613	148.841662
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41 n	Topsoil stockpile	-23.8446579	148.8485737
34	Topsoil stockpile	-23.87069893	148.8701853
17b	Topsoil stockpile	-23.87491608	148.8650623
18b	Topsoil stockpile	-23.87794495	148.8689974
231a	Topsoil stockpile	-23.77213614	148.8470965
46	Topsoil stockpile	-23.83518819	148.882622
259	Topsoil stockpile	-23.79070999	148.8708397

Table B2: Ground observations and surface descriptions.

Site ID	Groundcover % (veg)	Veg/Litter	Cracks (width)	Cracks (depth)	Stoniness (abundance)	Stoniness (size)
166	60-80%	80/20	<5mm		10-20%	
191	60-80%	80/20	5-10mm		2-10%	
165	80-100%	60/40	5-10mm		2-10%	
163	80-100%	80/20	<5mm		<2%	2-6mm
161	80-100%	80/20	<5mm		<2%	2-6mm
156	60-80%	80/20	<5mm		<2%	2-6mm
157	80-100%	80/20	<5mm		<2%	2-6mm
152	80-100%	80/21	<5mm		<2%	
130	80-100%	80/20	<5mm		<2%	2-6mm
126	80-100%	80/20	<5mm		<2%	2-6mm
124	80-100%	80/20	<5mm		<2%	2-6mm
123	80-100%	80/20	<5mm		2-10%	2-6mm
138a	40-60%	60/40	<5mm		20-50%	2-6mm
314	80-100%	80/20	<5mm		2-10%	2-6mm
111	80-100%	80/20	<5mm		<2%	
108	80-100%	80/20	<5mm		2-10%	2-6mm
270	80-100%	80/20	<5mm		2-10%	2-6mm
93	80-100%	80/20	<5mm		<2%	2-6mm
291a	80-100%	80/20	<5mm		<2%	2-6mm
291b	80-100%	80/21	<5mm		<2%	2-6mm
86	60-80%	80/20	5-10mm	20-50mm	2-10%	2-6mm
81a	60-80%	80/20	5-10mm	10-20mm	2-10%	2-6mm
82	80-100%	80/20	5-10mm	10-20mm	2-10%	2-6mm
73	80-100%	80/20	<5mm	10-20mm	<2%	2-6mm
67	80-100%	80/20	<5mm		<2%	
71	80-100%	80/20	<5mm	10-20mm	<2%	2-6mm
69	80-100%	80/20	<5mm	10-20mm	<2%	2-6mm
61	80-100%	80/20	<5mm	10-20mm	<2%	2-6mm
61 b	80-100%	80/21	<5mm	10-20mm	<2%	2-6mm
296	60-80%	80/20	<5mm		2-10%	
48	80-100%	100/0				
284	80-100%	100/0	<5mm	<10mm	10-20%	<60mm
268a	80-100%	100/0	<5mm	<10mm	10-20%	<60mm
268b	80-100%	100/0	5-10mm	<10mm		<60mm
256	80-100%	100/0	5-10mm	<10mm	10-20%	<60mm
17a	40-60%	60/40			10-20%	<60mm
18a	40-60%	60/40			50-90%	<200mm
255	80-100%	100/0				
210	80-100%	100/0				
102	80-100%	100/0				
103	80-100%	100/0				
214	80-100%	100/0				
216	80-100%	100/0				
188	80-100%	100/0				
145	80-100%	100/0				

Site ID	Groundcover % (veg)	Veg/Litter	Cracks (width)	Cracks (depth)	Stoniness (abundance)	Stoniness (size)
148	80-100%	100/0	5-10mm	<10mm		
228 a	80-100%	100/0				
228 b	80-100%	100/0	5-10mm	<10mm	<2%	2-6mm
231 b	80-100%	100/0			<2%	2-6mm
70	80-100%	100/0				
275	80-100%	100/0	5-10mm	<10mm	2-10%	2-6mm
278	80-100%	100/0	5-10mm	<10mm	<2%	<60mm
68	80-100%	100/0			<2%	2-6mm
72	80-100%	100/0	<5mm			
232	80-100%	100/0			2-10%	<60mm
62	80-100%	100/0	5-10mm	<10mm	2-10%	<200mm
250	80-100%	100/0			2-10%	
248	80-100%	100/0				
57	80-100%	100/0	5-10mm	10-20mm	20-50%	<200mm
55	80-100%	100/0	5-10mm	<10mm	20-50%	2-6mm
285	80-100%	100/0	<5mm	<10mm	<2%	2-6mm
52	80-100%	100/0	<5mm	<10mm	2-10%	2-6mm
47	80-100%	100/0	<5mm	<10mm	<2%	2-6mm
251	80-100%	80/20			2-10%	<20mm
253	80-100%	100/0				
267	80-100%	100/0	5-10mm	<10mm	10-20%	2-6mm
268c	80-100%	80/20	5-10mm	<10mm	2-10%	2-6mm
283	80-100%	100/0				
221	80-100%	100/0	<5mm	<10mm	2-10%	<20mm
45	80-100%	100/0			10-20%	<60mm
222	80-100%	100/0			2-10%	<60mm
59	80-100%	100/0				
218	80-100%	100/0				
170	80-100%	100/0	<5mm	<10mm	20-50%	2-6mm
219	80-100%	100/0	5-10mm	<10mm	2-10%	2-6mm
171	80-100%	100/0				
169	80-100%	100/0	5-10mm	<10mm	2-10%	2-6mm
58	80-100%	100/0				
2	80-100%	100/0	<5mm	<10mm		<60mm
11	80-100%	100/0	5-10mm	<10mm		
12	80-100%	100/0	<5mm	<10mm	2-10%	2-6mm
31	80-100%	100/0				
30	60-80%	80/20	<5mm	<10mm	20-50%	2-6mm
41	60-80%	100/0				
41 n	80-100%	100/0				
34	80-100%	100/0				
17b	80-100%	100/0				
18b	80-100%	100/0				
231a	80-100%	100/0				
46	80-100%	100/0				
259	80-100%	100/0				

Table B3: Morphological description of stockpiled soil materials.

Site ID	Date	Layer Depth (m)	Texture Group 1o	Texture Field	Colour (rapid)		Total Coarse Fragment %	Coarse Fragments 1°			Coarse Fragments 2°			Sample Type
					Primary	Secondary		%	Size	Shape	%	Size (mm)	Shape	
166	6/03/2023	0.5	CLAY	Light Clay	Brown	Pale Brown	5-10	2-5	6-20	Sub-rounded	2-5	6-20	Sub-angular	Grab
		1	CLAY	Medium Clay	Brown	Orange	5-10	5-10	6-20	Sub-rounded	2-5	6-20	Sub-angular	Grab
		2	CLAY	Medium Clay	Brown	Orange	5-10	5-10	6-20	Sub-rounded	2-5	6-20	Sub-angular	Grab
		composite	CLAY											Composite
191	6/03/2023	0.5	CLAY	Medium Heavy Clay	Brown	Red	2-5	2-5	6-20	Sub-rounded				Grab
		1	CLAY	Medium Heavy Clay	Brown	Red	5-10	2-5	6-20	Sub-rounded				Grab
		2	CLAY	Medium Heavy Clay	Dark Brown	Red	2-5	2-5	6-20	Sub-rounded				Grab
		composite	CLAY											Composite
165	7/03/2023	0.5	CLAY	Medium Clay	Brown	Pale Brown	2-5	2-5	6-20	Sub-angular				Grab
		1	CLAY	Medium Clay	Brown	Pale Brown	2-5	2-5	6-20	Sub-angular				Grab
		1.8	CLAY	Medium Clay	Brown	Dark Grey	2-5	2-5	6-20	Sub-angular				Grab
		composite	CLAY											Composite
163	7/03/2023	0.5	CLAY	Light Medium Clay	Brown		2-5	2-5	6-20	Sub-angular				Grab
		1	CLAY	Light Medium Clay	Brown		2-5	2-5	6-20	Sub-angular				Grab
		2	CLAY	Light Clay	Brown		2-5	2-5	6-20	Sub-angular				Grab
		composite	CLAY											Composite
161	7/03/2023	0.5	CLAY	Medium Clay	Black		2-5	<2	6-20	Sub-angular				Grab
		1	CLAY	Medium Clay	Black		2-5	<2	6-20	Sub-angular				Grab
		2	CLAY	Medium Clay	Black		2-5	<2	6-20	Sub-angular				Grab
		composite	CLAY											Composite
156	7/03/2023	0.5	CLAY	Medium Clay	Brown									Grab
		1	CLAY	Medium Clay	Brown		2-5	<2	6-20	Sub-rounded				Grab
		2	CLAY	Light Medium Clay	Brown		2-5	<2	6-20	Sub-rounded				Grab
		composite	CLAY											Composite
157	7/03/2023	0.5	CLAY	Light Medium Clay	Pale Brown		2-5	<2	6-20	Sub-angular				Grab
		1	CLAY	Light Medium Clay	Pale Brown		5-10	<2	6-20	Sub-angular				Grab
		2	CLAY	Light Medium Clay	Pale Brown		2-5	<2	6-20	Sub-angular				Grab
		composite	CLAY											Composite
152	7/03/2023	0.5	CLAY	Light Medium Clay	Brown		0							Grab
		1	CLAY	Light Medium Clay	Brown		0							Grab
		2.5	CLAY	Light Medium Clay	Brown		<2	<2	6-20	Sub-rounded				Grab
		composite	CLAY											Composite
130	7/03/2023	0.5	CLAY	Light Medium Clay	Pale Brown		2-5	2-5	2-6	Sub-angular				Grab
		1	CLAY	Light Medium Clay	Pale Brown		2-5	2-5	6-20	Sub-angular				Grab
		1.8	CLAY	Light Medium Clay	Pale Brown		<2	2-5	2-6	Sub-angular				Grab
		composite	CLAY											Composite
126	7/03/2023	0.5	CLAY	Medium Clay	Dark Brown		0							Grab
		1	CLAY	Medium Clay	Dark Brown	Orange	2-5	<2	2-6	Sub-rounded				Grab
		2	CLAY	Medium Clay	Dark Brown	Orange	2-5	<2	6-20	Sub-rounded				Grab
		composite	CLAY											Composite
124	7/03/2023	0.5	CLAY	Light Medium Clay	Brown		0							Grab
		1	CLAY	Light Medium Clay	Brown		2-5	<2	2-6	Sub-rounded				Grab
		2	CLAY	Light Clay	Brown		0							Grab
		composite	CLAY											Composite
123	8/03/2023	0.5	CLAY	Medium Clay	Brown	Black	5-10	5-10	2-6	Sub-angular				Grab
		1.5	CLAY	Light Medium Clay	Brown		0							Grab
		3	CLAY	Light Clay	Brown		0							Grab
		composite	CLAY											Composite

Site ID	Date	Layer Depth (m)	Texture Group 1o	Texture Field	Colour (rapid)		Total Coarse Fragment %	Coarse Fragments 1°			Coarse Fragments 2°			Sample Type
					Primary	Secondary		%	Size	Shape	%	Size (mm)	Shape	
138 a	8/03/2023	1m a	GRAVELLY CLAY	Light Medium Clay	Pale Grey	Pale Yellow	30-40	10-20	20-60	Sub-angular	5-10	6-20	Sub-rounded	Grab
		1m b	GRAVELLY CLAY	Light Medium Clay	Pale Grey	Pale Orange	30-40	10-20	20-60	Sub-angular	5-10	6-20	Sub-rounded	Grab
		1m c	GRAVELLY CLAY	Light Medium Clay	Pale Grey	Pale Orange	30-40	10-20	20-60	Sub-angular	5-10	6-20	Sub-rounded	Grab
		composite	GRAVELLY CLAY											Composite
314*	8/03/2023	0.5	CLAY	Light Medium Clay	Brown		<2	<2	2-6	Sub-rounded				Grab
		1	CLAY	Light Medium Clay	Brown		0							Grab
		2	CLAY	Clay Loam	Brown		0							Grab
		composite	CLAY											Composite
111	8/03/2023	0.5	CLAY	Light Medium Clay	Dark Brown		<2	<2	6-20	Sub-rounded				Grab
		1.5	CLAY	Light Medium Clay	Dark Brown		0							Grab
		3	CLAY	Light Medium Clay	Dark Brown		0							Grab
		composite	CLAY											Composite
108	8/03/2023	0.5	CLAY	Light Medium Clay	Dark Grey	Red	<2	<2	6-20	Sub-rounded				Grab
		1.5	CLAY	Light Medium Clay	Dark Brown	Red	0							Grab
		3	CLAY	Light Clay	Pale Yellow	Pale Brown	0							Grab
		composite	CLAY											Composite
270	8/03/2023	0.5	CLAY	Light Medium Clay	Black	Red	5-10	5-10	60-200	Sub-angular				Grab
		1.5	CLAY	Medium Clay	Black		0							Grab
		3	CLAY	Medium Clay	Black		0							Grab
		composite	CLAY											Composite
93	8/03/2023	0.5	CLAY	Light Medium Clay	Dark Grey	Red	2-5	2-5	20-60	Sub-angular				Grab
		1	CLAY	Light Medium Clay	Dark Brown	Red	0							Grab
		2	CLAY	Medium Clay	Dark Brown	Red	0							Grab
		composite	CLAY											Composite
291	8/03/2023	0.5	CLAY	Light Medium Clay	Brown	Pale Red	<2	<2	2-6	Sub-rounded				Grab
		1.5	CLAY	Medium Clay	Brown	Dark Grey	0							Grab
		3	CLAY	Medium Clay	Brown	Dark Grey	0							Grab
		composite	CLAY											Composite
291 (b)	8/03/2023	0.5	CLAY	Medium Clay	Brown	Dark Grey	5-10	5-10	6-20	Sub-rounded				Grab
		1	CLAY	Medium Clay	Brown	Pale Red	5-10	5-10	6-20	Sub-angular				Grab
		2	CLAY	Medium Clay	Brown	Pale Grey	10-20	10-20	20-60	Sub-angular	5-10	6-20	Sub-rounded	Grab
		composite	CLAY											Composite
86	8/03/2023	0.5	CLAY	Light Medium Clay	Dark Brown		5-10	5-10	6-20	Sub-rounded				Grab
		1.5	CLAY	Light Medium Clay	Dark Brown		0							Grab
		3	CLAY	Medium Clay	Dark Brown		0							Grab
		composite	CLAY											Composite
81	9/03/2023	1m a	CLAY	Light Clay	Brown		2-5	5-10	6-20	Sub-rounded				Grab
		1m b	CLAY	Clay Loam Sandy	Brown		2-5	5-10	6-20	Sub-angular				Grab
		1m c	CLAY	Clay Loam	Brown		2-5	5-10	6-20	Sub-rounded				Grab
		composite	CLAY											Composite
82	9/03/2023	0.5	CLAY	Light Medium Clay	Brown	Pale Orange	2-5	2-5	2-6	Sub-rounded				Grab
		1.5	CLAY	Light Medium Clay	Brown	Pale Orange	0							Grab
		2.5	CLAY	Light Medium Clay	Brown	Pale Orange	0							Grab
		composite	CLAY											Composite
73	9/03/2023	0.5	CLAY	Light Medium Clay	Dark Brown		0							Grab
		1.5	CLAY	Light Medium Clay	Dark Brown		0							Grab
		3	CLAY	Light Medium Clay	Dark Brown		0							Grab
		composite	CLAY											Composite

Site ID	Date	Layer Depth (m)	Texture Group 1o	Texture Field	Colour (rapid)		Total Coarse Fragment %	Coarse Fragments 1°			Coarse Fragments 2°			Sample Type
					Primary	Secondary		%	Size	Shape	%	Size (mm)	Shape	
67	9/03/2023	0.5	CLAY	Medium Clay	Dark Brown		0							Grab
		1.5	CLAY	Light Medium Clay	Brown		<2	<2	6-20	Sub-rounded				Grab
		3	CLAY	Light Medium Clay	Brown		0							Grab
		composite	CLAY											Composite
71	9/03/2023	0.5	CLAY	Medium Clay	Brown	Pale Orange	2-5	2-5	6-20	Sub-rounded				Grab
		1.5	CLAY	Medium Clay	Brown	Pale Orange	0							Grab
		2.5	CLAY	Medium Clay	Brown	Pale Orange	0							Grab
		composite	CLAY											Composite
69	9/03/2023	0.5	CLAY	Light Medium Clay	Brown	Pale Orange	2-5	2-5	6-20	Sub-rounded				Grab
		1.5	CLAY	Light Medium Clay	Brown	Pale Orange	2-5	2-5	6-20	Sub-rounded				Grab
		3	CLAY	Medium Clay	Brown	Pale Orange	0							Grab
		composite	CLAY											Composite
61	9/03/2023	0.5	CLAY	Light Clay	Brown		<2	<2	2-6	Sub-rounded				Grab
		1.5	CLAY	Light Medium Clay	Brown		0							Grab
		3	CLAY	Light Medium Clay	Brown		0							Grab
		composite	CLAY											Composite
61 (b)	9/03/2023	0.5	CLAY	Light Medium Clay	Brown	Dark Grey	2-5	2-5	6-20	Sub-rounded				Grab
		1.5	CLAY	Light Medium Clay	Brown		0							Grab
		3	CLAY	Light Clay	Brown		0							Grab
		composite	CLAY											Composite
18a	14/03/2023	0.5	LOAM	Sandy Clay Loam	Grey	Brown	30-40	30-40	20-60	Sub-rounded				Grab
		1.5	LOAM	Sandy Clay Loam	Grey	Brown	30-40	30-40	20-60	Sub-rounded				Grab
		composite	LOAM				0							Composite
			LOAM											
18b	14/03/2023	0.5	LOAM	Sandy Clay Loam	Grey	Brown	30-40	30-40	20-60	Sub-rounded				Grab
		1.5	LOAM	Sandy Clay Loam	Grey	Brown	30-40	30-40	20-60	Sub-rounded				Grab
		composite	LOAM											Composite
			LOAM											
17a	14/03/2023	0.5	LOAM	Sandy Loam	Grey	Brown	10-20	10-20	20-60	Sub-rounded				Grab
		1.5	LOAM	Sandy Loam	Grey	Brown	10-20	10-20	20-60	Sub-rounded				Grab
		composite	LOAM											Composite
			LOAM											
17b	14/03/2023	0.5	LOAM	Sandy Loam	Grey	Brown	10-20	10-20	20-60	Sub-rounded				Grab
		1.5	LOAM	Sandy Loam	Grey	Brown	10-20	10-20	20-60	Sub-rounded				Grab
		composite	LOAM											Composite
			LOAM											
296	14/03/2023	0.5	LOAM	Clayey Sand	Red	Brown	30-40	30-40	20-60	Sub-rounded				Grab
		1.5	LOAM	Sandy Loam	Pale Red	Brown	30-40	30-40	20-60	Sub-rounded				Grab
		2.5	LOAM	Sandy Clay Loam	Pale Red	Brown	30-40	30-40	20-60	Sub-rounded				Grab
		composite	LOAM											Composite
48	14/03/2023	0.5	CLAY	Light Medium Clay	Dark Brown		0							Grab
		1.5	CLAY	Light Clay	Brown	Pale Red	0							Grab
		2.5	CLAY	Medium Clay	Brown	Red	0							Grab
		composite	CLAY											Composite
284	14/03/2023	0.5	CLAY	Light Clay	Red	Brown	10-20	5-10	20-60	Sub-rounded	5-10	6-20	Sub-rounded	Grab
		1.5	CLAY	Light Medium Clay	Pale Red	Brown	10-20	5-10	20-60	Sub-rounded	5-10	6-20	Sub-rounded	Grab
		2.5	CLAY	Medium Clay	Pale Red	Brown	5-10	5-10	20-60	Sub-angular	5-10	6-20	Sub-rounded	Grab
		composite	CLAY					0						Composite

Site ID	Date	Layer Depth (m)	Texture Group 1o	Texture Field	Colour (rapid)		Total Coarse Fragment %	Coarse Fragments 1°			Coarse Fragments 2°			Sample Type
					Primary	Secondary		%	Size	Shape	%	Size (mm)	Shape	
268a	14/03/2023	0.5	GRAVELLY CLAY	Light Medium Clay	Red	Brown	20-30	5-10	60-200	Sub-angular	10-20	6-20	Sub-rounded	Grab
		1.5	GRAVELLY CLAY	Light Medium Clay	Pale Red	Brown	20-30	10-20	60-200	Sub-angular	5-10	6-20	Sub-rounded	Grab
		2.5	GRAVELLY CLAY	Light Medium Clay	Pale Red	Brown	<2	<2	2-6	Sub-angular				Grab
		composite	GRAVELLY CLAY											Composite
268b	14/03/2023	0.5	GRAVELLY CLAY	Medium Heavy Clay	Red	Brown	30-40	20-30	6-20	Sub-rounded	10-20	60-200	Sub-angular	Grab
		1.5	GRAVELLY CLAY	Medium Heavy Clay	Pale Red	Brown	40-60	30-40	60-200	Sub-angular	5-10	20-60	Sub-angular	Grab
		2.5	GRAVELLY CLAY	Medium Heavy Clay	Pale Red	Brown	30-40	20-30	60-200	Sub-angular	5-10	6-20	Sub-rounded	Grab
		composite	GRAVELLY CLAY											Composite
256	15/03/2023	0.5	GRAVELLY CLAY	Light Clay	Red	Brown	20-30	10-20	20-60	Sub-rounded	10-20	6-20	Sub-angular	Grab
		1.5	GRAVELLY CLAY	Light Clay	Pale Red	Brown	20-30	10-20	20-60	Sub-rounded	10-20	6-20	Sub-angular	Grab
		2.5	GRAVELLY CLAY	Medium Clay	Pale Red	Brown	20-30	10-20	20-60	Sub-rounded	10-20	2-6	Sub-angular	Grab
		composite	GRAVELLY CLAY											Composite
255	15/03/2023	0.5	CLAY	Medium Clay	Red	Brown	0							Grab
		1	CLAY	Medium Clay	Red	Brown	0							Grab
		1.5	CLAY	Medium Clay	Red	Brown	0							Grab
		composite	CLAY											Composite
210	16/03/2023	0.5	CLAY	Medium Heavy Clay	Grey	Brown	2-5	2-5	20-60	Sub-angular			Sub-rounded	Grab
		1.5	CLAY	Medium Heavy Clay	Grey	Brown	2-5	2-5	6-20	Sub-angular				Grab
		2.5	CLAY	Medium Heavy Clay	Grey	Brown	2-5	2-5	6-20	Sub-angular				Grab
		composite	CLAY											Composite
102	16/03/2023	0.5	CLAY	Medium Heavy Clay	Red	Brown	<2	<2	2-6	Sub-angular				Grab
		1.5	CLAY	Medium Heavy Clay	Red	Brown	<2	<2	2-6	Sub-angular				Grab
		2.5	CLAY	Medium Heavy Clay	Red	Brown	<2	<2	2-6	Sub-angular				Grab
		composite	CLAY											Composite
103	16/03/2023	0.5	CLAY	Light Medium Clay	Red	Brown	5-10	5-10	20-60	Sub-angular				Grab
		1.5	CLAY	Light Clay	Pale Red	Brown	5-10	5-10	20-60	Sub-angular				Grab
		2.5	CLAY	Silty Loam	Pale Yellow	Brown	40-60	30-40	60-200	Sub-angular	20-30	20-60	Sub-angular	Grab
		composite	CLAY											Composite
214	16/03/2023	0.5	GRAVELLY CLAY	Medium Clay	Red	Brown	10-20	10-20	20-60	Sub-angular				Grab
		1.5	GRAVELLY CLAY	Medium Clay	Pale Red	Brown	20-30	5-10	60-200	Sub-angular	10-20	6-20	Sub-angular	Grab
		2.5	GRAVELLY CLAY	Medium Clay	Pale Red	Brown	40-60	20-30	60-200	Sub-angular	20-30	6-20	Sub-angular	Grab
		composite	GRAVELLY CLAY											Composite
216	16/03/2023	0.5	CLAY	Medium Clay	Red	Brown	10-20	10-20	6-20	Sub-angular				Grab
		1,5	CLAY	Medium Clay	Red	Brown	20-30	20-30	6-20	Sub-angular			Sub-rounded	Grab
		2.5	CLAY	Medium Clay	Red	Brown	5-10	5-10	6-20	Sub-angular				Grab
		composite	CLAY											Composite
188	16/03/2023	0.5	CLAY	Light Clay	Red	Brown	0							Grab
		1.5	CLAY	Light Clay	Red	Brown	0							Grab
		2.5	CLAY	Light Clay	Red	Brown	5-10	2-5	20-60	Sub-rounded	2-5	2-6	Sub-rounded	Grab
		composite	CLAY											Composite
145	17/03/2023	1m a	CLAY	Medium Clay	Grey	Brown	<2	<2	2-6	Sub-rounded				Grab
		1m b	CLAY	Medium Clay	Grey	Brown	<2	<2	2-6	Sub-rounded				Grab
		1m c	CLAY	Medium Clay	Grey	Brown	<2	<2	2-6	Sub-rounded				Grab
		composite	CLAY											Composite

Site ID	Date	Layer Depth (m)	Texture Group 1o	Texture Field	Colour (rapid)		Total Coarse Fragment %	Coarse Fragments 1°			Coarse Fragments 2°			Sample Type
					Primary	Secondary		%	Size	Shape	%	Size (mm)	Shape	
148	17/03/2023	1m a	CLAY	Light Medium Clay	Red	Brown	0							Grab
		1m b	CLAY	Light Medium Clay	Red	Brown	0							Grab
		1m c	CLAY	Light Medium Clay	Red	Brown	0							Grab
		composite	CLAY											Composite
228a	17/03/2023	0.5	GRAVELLY CLAY	Light Clay	Red	Brown	10-20	5-10	20-60	Sub-angular	5-10	6-20	Sub-rounded	Grab
		1.5	GRAVELLY CLAY	Light Clay	Red	Brown	10-20	5-10	20-60	Sub-angular	5-10	6-20	Sub-rounded	Grab
		2/01/1900	GRAVELLY CLAY	Light Medium Clay	Red	Brown	10-20	5-10	20-60	Sub-angular	5-10	6-20	Sub-rounded	Grab
		composite	GRAVELLY CLAY											Composite
228 b	17/03/2023	0.5	GRAVELLY CLAY	Light Medium Clay	Red	Brown	30-40	5-10	20-60	Sub-angular	20-30	6-20	Sub-angular	Grab
		1.5	GRAVELLY CLAY	Medium Clay	Pale Red	Brown	40-60	20-30	60-200	Sub-angular	20-30	20-60	Sub-angular	Grab
		2.5	GRAVELLY CLAY	Medium Clay	Pale Red	Brown	5-10	5-10	6-20	Sub-angular				Grab
		composite	GRAVELLY CLAY											Composite
231 a	17/03/2023	0.5	CLAY	Light Medium Clay	Red	Brown	5-10	5-10	6-20	Sub-angular				Grab
		1.5	CLAY	Light Medium Clay	Red	Brown	5-10	5-10	6-20	Sub-angular				Grab
		2.5	CLAY	Light Medium Clay	Red	Brown	5-10	5-10	6-20	Sub-angular				Grab
		composite	CLAY											Composite
231 b	17/03/2023	0.5	CLAY	Light Clay	Red	Brown	2-5	<2	20-60	Sub-angular	<2	6-20	Sub-angular	Grab
		1.5	CLAY	Light Clay	Red	Brown	2-5	<2	20-60	Sub-angular	<2	6-20	Sub-angular	Grab
		2 (on bag - 2-2.5r	CLAY	Light Clay	Red	Brown	2-5	<2	20-60	Sub-angular	<2	6-20	Sub-angular	Grab
		composite	CLAY											Composite
70	18/03/2023	0.5	GRAVELLY CLAY	Medium Clay	Dark Brown		20-30	5-10	60-200	Sub-angular	20-30	20-60	Sub-angular	Grab
		1.5	GRAVELLY CLAY	Medium Clay	Dark Brown		20-30	5-10	60-200	Sub-angular	20-30	20-60	Sub-angular	Grab
		2.5	GRAVELLY CLAY	Medium Clay	Dark Brown		20-30	5-10	60-200	Sub-angular	20-30	20-60	Sub-angular	Grab
		composite	GRAVELLY CLAY											Composite
275	18/03/2023	0.5	CLAY	Light Medium Clay	Dark Brown		0							Grab
		1.5	CLAY	Light Medium Clay	Brown	Pale Red	0							Grab
		2.5	CLAY	Light Medium Clay	Brown	Pale Red	0							Grab
		composite	CLAY		Dark Brown									Composite
278	18/03/2023	0.5	CLAY	Medium Heavy Clay	Dark Brown	Red	0							Grab
		1.5	CLAY	Medium Heavy Clay	Brown	Red	0							Grab
		2.5	CLAY	Medium Heavy Clay	Brown	Red	<2	<2	2-6	Sub-angular				Grab
		composite	CLAY											Composite
68	18/03/2023	0.5	CLAY	Light Medium Clay	Dark Brown		0							Grab
		1.5	CLAY	Clayey Sand	Brown	Pale Red	2-5	2-5	6-20	Sub-angular				Grab
		2.5	CLAY	Clayey Sand	Brown	Pale Red	2-5	2-5	6-20	Sub-angular				Grab
		composite	CLAY											Composite
72	18/03/2023	0.5	CLAY	Medium Clay	Brown	Red	0							Grab
		1.5	CLAY	Light Medium Clay	Brown	Red	0							Grab
		2.5	CLAY	Light Medium Clay	Brown	Red	2-5	2-5	2-6	Sub-angular				Grab
		composite	CLAY											Composite
232	18/03/2023	0.5	CLAY	Medium Clay	Brown	Red	5-10	5-10	20-60	Sub-angular				Grab
		1.5	CLAY	Medium Clay	Brown	Red	5-10	5-10	20-60	Sub-angular				Grab
		2.5	CLAY	Medium Clay	Brown	Red	5-10	5-10	20-60	Sub-angular				Grab
		composite	CLAY											Composite
62	18/03/2023	0.5	CLAY	Medium Heavy Clay	Dark Brown	Red	<2	<2	6-20	Sub-angular				Grab
		1.5	CLAY	Medium Heavy Clay	Brown	Red	<2	<2	6-20	Sub-angular				Grab
		2.5	CLAY	Medium Heavy Clay	Brown	Red	<2	<2	6-20	Sub-angular				Grab
		composite	CLAY											Composite

Site ID	Date	Layer Depth (m)	Texture Group 1o	Texture Field	Colour (rapid)		Total Coarse Fragment %	Coarse Fragments 1°			Coarse Fragments 2°			Sample Type
					Primary	Secondary		%	Size	Shape	%	Size (mm)	Shape	
250	18/03/2023	0.5	CLAY	Medium Clay	Dark Brown	Red	<2	<2	6-20	Sub-angular				Grab
		1.5	CLAY	Medium Clay	Brown	Red	<2	<2	6-20	Sub-angular				Grab
		2.5	CLAY	Medium Clay	Brown	Red	<2	<2	6-20	Sub-angular				Grab
		composite	CLAY											Composite
248	18/03/2023	0.5	CLAY	Light Medium Clay	Brown	Red	0							Grab
		1.5	CLAY	Light Medium Clay	Brown	Red	5-10	5-10	20-60	Sub-angular				Grab
		2.5	CLAY	Light Medium Clay	Brown	Red	5-10	2-5	20-60	Sub-angular				Grab
		composite	CLAY											Composite
57	18/03/2023	0.5	CLAY	Medium Heavy Clay	Dark Brown	Dark Grey	10-20	2-5	60-200	Sub-angular	5-10	2-6	Sub-angular	Grab
		1.5	CLAY	Medium Heavy Clay	Dark Brown	Dark Grey	10-20	2-5	60-200	Sub-angular	5-10	2-6	Sub-angular	Grab
		2.5	CLAY	Medium Heavy Clay	Dark Brown	Dark Grey	10-20	2-5	60-200	Sub-angular	5-10	2-6	Sub-angular	Grab
		composite	CLAY											Composite
55	19/03/2023	0.5	CLAY	Medium Heavy Clay	Dark Grey	Brown	<2	<2	2-6	Sub-angular				Grab
		1.5	CLAY	Medium Heavy Clay	Dark Grey	Brown	<2	<2	2-6	Sub-angular				Grab
		2.5	CLAY	Medium Heavy Clay	Dark Grey	Brown	<2	<2	2-6	Sub-angular				Grab
		composite	CLAY											Composite
285	19/03/2023	0.5	CLAY	Light Medium Clay	Red	Brown	<2	<2	2-6	Sub-rounded				Grab
		1.5	CLAY	Light Medium Clay	Red	Brown	<2	<2	2-6	Sub-rounded				Grab
		2.5	CLAY	Light Medium Clay	Red	Brown	<2	<2	6-20	Sub-rounded				Grab
		composite	CLAY											Composite
52	19/03/2023	0.5	CLAY	Light Medium Clay	Brown	Red	<2	<2	2-6	Sub-angular				Grab
		1.5	CLAY	Light Medium Clay	Brown	Red	<2	<2	6-20	Sub-angular				Grab
		2.5	CLAY	Light Medium Clay	Brown	Red	<2	<2	2-6	Sub-angular				Grab
		composite	CLAY											Composite
47	19/03/2023	0.5	LOAM	Clayey Sand	Red	Brown	<2	<2	2-6	Sub-angular				Grab
		1.5	LOAM	Clayey Sand	Red	Brown	<2	<2	2-6	Sub-angular				Grab
		2.5	LOAM	Sandy Clay Loam	Red	Brown	<2	<2	2-6	Sub-angular				Grab
		composite	LOAM											Composite
46	19/03/2023	0.5	LOAM	Clayey Sand	Red	Brown	<2	<2	2-6	Sub-angular				Grab
		1.5	LOAM	Light Clay	Red	Brown	<2	<2	2-6	Sub-angular				Grab
		2.5	LOAM	Light Clay	Red	Brown	<2	<2	2-6	Sub-angular				Grab
		composite	LOAM											Composite
251	19/03/2023	0.5	LOAM	Silty Loam	Pale Red	Brown	2-5	2-5	2-6	Sub-rounded				Grab
		1.5	LOAM	Silty Loam	Pale Red	Brown	2-5	2-5	2-6	Sub-rounded				Grab
		2.5	LOAM	Silty Loam	Pale Red	Brown	2-5	2-5	2-6	Sub-rounded				Grab
		composite	LOAM	Silty Loam										Composite
253	19/03/2023	0.5	LOAM	Silty Clay Loam	Red	Brown	<2	<2	2-6	Sub-rounded				Grab
		1.5	LOAM	Silty Clay Loam	Red	Brown	<2	<2	2-6	Sub-rounded				Grab
		2.5	LOAM	Silty Clay Loam	Red	Brown	<2	<2	2-6	Sub-rounded				Grab
		composite	LOAM											Composite
267	19/03/2023	0.5	GRAVELLY CLAY	Medium Heavy Clay	Red	Brown	40-60	40-60	20-60	Sub-rounded				Grab
		1.5	GRAVELLY CLAY	Medium Heavy Clay	Red	Brown	40-60	40-60	20-60	Sub-rounded				Grab
		2.5	GRAVELLY CLAY	Medium Heavy Clay	Red	Brown	40-60	40-60	20-60	Sub-rounded				Grab
		composite	GRAVELLY CLAY											Composite
268c	19/03/2023	0.5	CLAY	Medium Clay	Red	Brown	<2	<2	2-6	Sub-rounded				Grab
		1.5	CLAY	Medium Clay	Red	Brown	5-10	5-10	6-20	Sub-rounded				Grab
		2.5	CLAY	Medium Clay	Red	Brown	2-5	2-5	2-6	Sub-rounded				Grab
		composite	CLAY											Composite

Site ID	Date	Layer Depth (m)	Texture Group 1o	Texture Field	Colour (rapid)		Total Coarse Fragment %	Coarse Fragments 1°			Coarse Fragments 2°			Sample Type
					Primary	Secondary		%	Size	Shape	%	Size (mm)	Shape	
283	19/03/2023	0.5	CLAY	Medium Clay	Red	Brown	<2	<2	6-20	Sub-angular				Grab
		1.5	CLAY	Medium Clay	Red	Brown	5-10	2-5	60-200	Sub-angular	2-5	2-6	Sub-angular	Grab
		2.5	CLAY	Medium Clay	Red	Brown	5-10	2-5	20-60	Sub-angular	2-5	2-6	Sub-angular	Grab
		composite	CLAY											Composite
221	19/03/2023	0.5	GRAVELLY CLAY	Clayey Sand	Grey	Brown	40-60	30-40	60-200	Sub-angular	10-20	6-20	Sub-angular	Grab
		1.5	GRAVELLY CLAY	Light Clay	Grey	Brown	40-60	30-40	60-200	Sub-angular	10-20	6-20	Sub-angular	Grab
		2.5	GRAVELLY CLAY	Light Clay	Pale Red	Pale Grey	40-60	30-40	60-200	Sub-angular	10-20	6-20	Sub-angular	Grab
		composite	GRAVELLY CLAY											Composite
45	19/03/2023	0.5	GRAVELLY CLAY	Light Medium Clay	Pale Red	Pale Red	40-60	20-30	60-200	Sub-angular	20-30	20-60	Sub-angular	Grab
		1.5	GRAVELLY CLAY	Light Medium Clay	Pale Red	Pale Red	40-60	20-30	60-200	Sub-angular	20-30	20-60	Sub-angular	Grab
		2.5	GRAVELLY CLAY	Light Medium Clay	Pale Red	Pale Red	40-60	20-30	60-200	Sub-angular	20-30	20-60	Sub-angular	Grab
		composite	GRAVELLY CLAY											Composite
222	19/03/2023	0.5	GRAVELLY CLAY	Medium Clay	Red	Brown	40-60	30-40	60-200	Sub-angular	10-20	20-60	Sub-angular	Grab
		1.5	GRAVELLY CLAY	Medium Clay	Red	Brown	40-60	30-40	60-200	Sub-angular	10-20	20-60	Sub-angular	Grab
		2.5	GRAVELLY CLAY	Medium Clay	Red	Brown	40-60	30-40	60-200	Sub-angular	10-20	20-60	Sub-angular	Grab
		composite	GRAVELLY CLAY											Composite
259	19/03/2023	0.5	GRAVELLY CLAY	Medium Heavy Clay	Red	Brown	40-60	30-40	60-200	Sub-angular	10-20	6-20	Sub-angular	Grab
		1	GRAVELLY CLAY	Medium Heavy Clay	Red	Brown	40-60	30-40	60-200	Sub-angular	10-20	6-20	Sub-angular	Grab
		2	GRAVELLY CLAY	Medium Heavy Clay	Red	Yellow	40-60	30-40	60-200	Sub-angular	10-20	6-20	Sub-angular	Grab
		composite	GRAVELLY CLAY											Composite
59	20/03/2023	1ma	CLAY	Light Medium Clay	Brown	Red	0							Grab
		1 m b	CLAY	Light Medium Clay	Brown	Red	0							Grab
		1 m c	CLAY	Light Medium Clay	Red	Brown	0							Grab
		composite	CLAY											Composite
218	20/03/2023	0.5	CLAY	Light Clay	Red	Brown	<2	<2	2-6	Sub-angular				Grab
		1.5	CLAY	Light Clay	Red	Brown	0							Grab
		2.5	CLAY	Light Clay	Red	Brown	0							Grab
		composite	CLAY											Composite
170	20/03/2023	0.5	CLAY	Medium Heavy Clay	Brown	Red	0							Grab
		1.5	CLAY	Medium Heavy Clay	Brown	Red	0							Grab
		2.5	CLAY	Medium Heavy Clay	Brown	Red	0							Grab
		composite	CLAY											Composite
219	20/03/2023	0.5	CLAY	Medium Heavy Clay	Brown	Grey	0							Grab
		1.5	CLAY	Medium Heavy Clay	Brown	Grey	0							Grab
		2.5	CLAY	Medium Heavy Clay	Brown	Grey	0							Grab
		composite	CLAY											Composite
171	20/03/2023	0.5	CLAY	Medium Clay	Brown	Red	5-10	<2	200-600	Sub-angular	5-10	20-60	Sub-angular	Grab
		1.5	CLAY	Medium Clay	Brown	Red	5-10	5-10	20-60	Sub-angular				Grab
		2.5	CLAY	Medium Clay	Brown	Red	5-10	5-10	20-60	Sub-angular				Grab
		composite	CLAY											Composite
169	20/03/2023	0.5	CLAY	Medium Clay	Brown	Grey	<2	<2	6-20	Sub-angular				Grab
		1.5	CLAY	Medium Clay	Brown	Grey	<2	<2	6-20	Sub-angular				Grab
		2.5	CLAY	Medium Heavy Clay	Brown	Grey	<2	<2	6-20	Sub-angular				Grab
		composite	CLAY											Composite
58	20/03/2023	0.5	CLAY	Medium Clay	Brown	Grey	<2	<2	6-20	Sub-angular				Grab
		1.5	CLAY	Medium Clay	Brown	Grey	<2	<2	6-20	Sub-angular				Grab
		2.5	CLAY	Medium Clay	Brown	Grey	<2	<2	6-20	Sub-angular				Grab
		composite	CLAY											Composite

Site ID	Date	Layer Depth (m)	Texture Group 1o	Texture Field	Colour (rapid)		Total Coarse Fragment %	Coarse Fragments 1°			Coarse Fragments 2°			Sample Type
					Primary	Secondary		%	Size	Shape	%	Size (mm)	Shape	
2	20/03/2023	0.5	CLAY	Medium Heavy Clay	Red	Brown	0							Grab
		1.5	CLAY	Medium Heavy Clay	Red	Brown	0							Grab
		2.5	CLAY	Medium Heavy Clay	Red	Brown	0							Grab
		composite	CLAY											Composite
11	20/03/2023	0.5	CLAY	Medium Heavy Clay	Red	Brown	<2	<2	6-20	Sub-angular				Grab
		1.5	CLAY	Medium Heavy Clay	Red	Brown	<2	<2	6-20	Sub-angular				Grab
		2.5	CLAY	Medium Heavy Clay	Red	Brown	<2	<2	6-20	Sub-angular				Grab
		composite	CLAY											Composite
12	20/03/2023	0.5	CLAY	Medium Heavy Clay	Red	Brown	<2	<2	6-20	Sub-angular				Grab
		1.5	CLAY	Medium Heavy Clay	Red	Brown	<2	<2	6-20	Sub-angular				Grab
		2.5	CLAY	Medium Heavy Clay	Red	Brown	<2	<2	6-20	Sub-angular				Grab
		composite	CLAY											Composite
31	20/03/2023	0.5	CLAY	Light Clay	Red	Brown	0							Grab
		1.5	CLAY	Light Clay	Red	Brown	0							Grab
		2.5	CLAY	Light Clay	Red	Brown	0							Grab
		c	CLAY											Composite
30	20/03/2023	0.5	CLAY	Light Medium Clay	Red	Brown	5-10	5-10	20-60	Sub-angular				Grab
		1.5	CLAY	Light Medium Clay	Red	Brown	5-10	5-10	20-60	Sub-angular				Grab
		2.5	CLAY	Light Medium Clay	Red	Brown	5-10	5-10	20-60	Sub-angular				Grab
		composite	CLAY											Composite
41	20/03/2023	0.5	CLAY	Light Clay	Red	Brown	<2	<2	20-60	Sub-angular				Grab
		1.5	CLAY	Light Clay	Red	Brown	0							Grab
		2.5	CLAY	Light Clay	Red	Brown	0							Grab
		composite	CLAY											Composite
41 N	20/03/2023	0.5	CLAY	Light Clay	Red	Brown	0							Grab
		1.5	CLAY	Light Clay	Red	Brown	0							Grab
		2.5	CLAY	Light Clay	Red	Brown	0							Grab
		composite	CLAY											Composite
34	20/03/2023	0.5	LOAM	Sandy Loam	Pale Grey		20-30	10-20	60-200	Sub-angular	5-10	6-20	Sub-angular	Grab
		1.5	LOAM	Sandy Loam	Pale Grey		20-30	10-20	2-6	Sub-angular	5-10	6-20	Sub-angular	Grab
		2.5	LOAM	Sandy Loam	Pale Grey		20-30	10-20	2-6	Sub-angular	5-10	6-20	Sub-angular	Grab
		composite	LOAM											Composite

Table B4: Laboratory analysis data for loam topsoils. Part 1 of 3.

Table B4. Laboratory Results Loams											
	Lab No	230959-119		230959-122		230959-125		230959-128		230959-132	
	Sample ID	18a		18b		17a		17b		296	
	Sample Depth	Composite		Composite		Composite		Composite		Composite	
	Field Texture	SCL		SCL		SL		SL		SCL	
Analyses	**Unit**	-		-		-		-		-	
pH - Water	pH units	4.79	*VH.Acid*	4.66	*VH.Acid*	4.97	*VH.Acid*	5.09	*VH.Acid*	5.25	*H.Acid*
Electrical Conductivity	dS/m	0.08	*VL.Sal*	0.07	*VL.Sal*	0.05	*VL.Sal*	0.05	*VL.Sal*	0.1	*L.Sal*
Chloride	mg/kg	55.9	*VL.Sal*	38.6	*VL.Sal*	16.5	*VL.Sal*	43.6	*VL.Sal*	50.3	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	1570.0	*M*	1310.0	*L*	843.0	*L*	700.0	*L*	790.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	92.9	*	<40.0	*	70.5	*	104.0	*	102.0	*
Phosphorus - Colwell extr	mg/kg	16.5	*M*	18.3	*M*	30.5	*H*	21.9	*H*	10.7	*L*
Potassium - Colwell ext	mg/kg	135.00	*L*	147.00	*L*	96.00	*L*	147.00	*L*	124.00	*L*
Sulphur - KCl	mg/kg	11.9	*M*	10.7	*M*	6.7	*L*	9.8	*M*	10.4	*M*
Organic Carbon	%	2.44	*H*	1.94	*H*	1.11	*M*	1.01	*M*	1.03	*M*
Copper	mg/kg	0.21	*L*	<0.20	*L*	<0.20	*L*	<0.20	*L*	0.29	*L*
Iron	mg/kg	171.00	*	148.00	*	77.30	*	54.10	*	96.80	*
Manganese	mg/kg	5.22	*M*	3.22	*M*	5.00	*M*	5.26	*M*	3.88	*M*
Zinc	mg/kg	0.48	*L*	0.22	*L*	0.22	*L*	0.20	*L*	0.24	*L*
Boron	mg/kg	0.42	*VL*	0.38	*VL*	0.40	*VL*	0.34	*VL*	0.40	*VL*
Cation Extraction Method	Rayment& Lyons	15A1	*	15A1	*	15A1	*	15A1	*	15A1	*
Cation Exchange Capacity	meq/100g	4.3	*VL*	3.5	*VL*	2.3	*VL*	3.1	*VL*	3.8	*VL*
Ex Calcium Percent	%	33.33	*L*	10.94	*L*	54.13	*L*	50.93	*L*	57.43	*L*
Ex Magnesium Percent	%	8.01	*L*	2.40	*L*	8.66	*L*	15.17	*H*	23.27	*H*
Ex Potassium Percent	%	3.36	*Normal*	2.10	*Normal*	6.78	*H*	12.44	*H*	5.02	*H*
Ex Sodium Percent	%	1.1	*N.Sodic*	1.3	*N.Sodic*	1.9	*N.Sodic*	4.0	*N.Sodic*	4.7	*N.Sodic*
Ex Aluminium Percent	%	54.20	*VH*	83.30	*VH*	28.55	*H*	17.42	*M*	9.57	*L*
Exchangeable Calcium	mg/kg	287	*H*	75.9	*Normal*	249	*H*	319	*H*	436	*H*
Exchangeable Magnesium	mg/kg	41.4	*H*	10	*Normal*	23.9	*H*	57	*H*	106	*H*
Exchangeable Potassium	mg/kg	56.4	*H*	28.4	*H*	60.8	*H*	152	*H*	74.3	*H*
Exchangeable Sodium	mg/kg	10.9	*Sodic*	10	*Sodic*	10	*Sodic*	29.1	*H.Sodic*	41.1	*H.Sodic*
Exchangeable Aluminium	mg/kg	210.00	*FALSE*	260.00	*FALSE*	59.10	*VH*	49.10	*VH*	32.70	*H*
Exchangeable Calcium	meq/100g	1.44	*VL*	0.38	*VL*	1.25	*VL*	1.60	*VL*	2.18	*L*
Exchangeable Magnesium	meq/100g	0.35	*L*	0.08	*VL*	0.20	*VL*	0.48	*L*	0.88	*L*
Exchangeable Potassium	meq/100g	0.14	*VL*	0.07	*VL*	0.16	*VL*	0.39	*M*	0.19	*VL*
Exchangeable Sodium	meq/100g	0.05	*VL*	0.04	*VL*	0.04	*VL*	0.13	*L*	0.18	*L*
Exchangeable Aluminium	meq/100g	2.33	*E*	2.89	*E*	0.66	*E*	0.55	*E*	0.36	*E*
Calcium/Magnesium Ratio	-	4.2	*Balanced*	4.6	*Balanced*	6.3	*Balanced*	3.4	*Low Ca*	2.5	*Low Ca*
Emerson Aggregate	Class	5	*Slaking*	5	*Slaking*	5	*Slaking*	3b	*Slight Disp*	5	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B4: Laboratory analysis data for loam topsoils. Part 2 of 3.

TABLE B4. Laboratory Results Loams											
	Lab No	230959-264		230959-268		230959-272		230959-276		230959-364	
	Sample ID	47		46		251		253		34	
	Sample Depth	Composite		Composite		Composite		Composite		Composite	
	Field Texture	LMC		LMC		LMC		LMC		SL	
Analyses	**Unit**	-		-		-		-		-	
pH - Water	pH units	6.76	*Neutral*	7.67	*L.Alk*	7.44	*L.Alk*	7.68	*L.Alk*	5.45	*H.Acid*
Electrical Conductivity	dS/m	0.17	*L.Sal*	0.32	*M.Sal*	0.22	*M.Sal*	0.18	*L.Sal*	0.04	*VL.Sal*
Chloride	mg/kg	28.8	*VL.Sal*	44.0	*VL.Sal*	64.9	*VL.Sal*	164.0	*L.Sal*	20.3	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	1245.0	*L*	1450.0	*L*	1240.0	*L*	888.0	*L*	627.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	380.0	*	401.0	*	286.0	*	131.0	*	63.7	*
Phosphorus - Colwell extr	mg/kg	13.6	*L*	21.9	*L*	14.2	*L*	9.35	*L*	<5.00	*L*
Potassium - Colwell ext	mg/kg	215.00	*M*	255.00	*M*	232.00	*M*	138.00	*L*	124.00	*L*
Sulphur - KCl	mg/kg	11.2	*M*	19.5	*H*	15.9	*H*	21.3	*VH*	7.8	*L*
Organic Carbon	%	1.22	*M*	1.21	*M*	1.12	*M*	0.82	*L*	0.69	*L*
Copper	mg/kg	0.73	*M*	0.75	*M*	0.67	*M*	0.59	*M*	<0.20	*
Iron	mg/kg	13.60	*	11.10	*	7.98	*	8.28	*	46.90	*
Manganese	mg/kg	12.30	*M*	6.95	*M*	7.43	*M*	7.40	*M*	2.34	*M*
Zinc	mg/kg	0.60	*M*	0.88	*M*	0.58	*L*	0.40	*L*	1.91	*M*
Boron	mg/kg	0.89	*L*	1.05	*M*	1.01	*M*	1.03	*M*	0.23	*VL*
Cation Extraction Method	Rayment& Lyons	15A1	*	15C1	*	15C1	*	15C1	*	15A1	*
Cation Exchange Capacity	meq/100g	10.4	*L*	8.8	*L*	8.1	*L*	6.3	*L*	3.2	*VL*
Ex Calcium Percent	%	75.86	*Normal*	73.06	*Normal*	74.32	*Normal*	72.18	*Normal*	66.52	*Normal*
Ex Magnesium Percent	%	19.27	*H*	20.03	*H*	18.42	*H*	18.72	*H*	24.62	*H*
Ex Potassium Percent	%	3.91	*Normal*	6.05	*H*	5.60	*H*	4.82	*Normal*	3.77	*Normal*
Ex Sodium Percent	%	0.7	*N.Sodic*	0.62	*N.Sodic*	1.38	*N.Sodic*	3.92	*N.Sodic*	2.8	*N.Sodic*
Ex Aluminium Percent	%	0.21	*VL*	0.25	*VL*	0.28	*VL*	0.35	*VL*	2.26	*VL*
Exchangeable Calcium	mg/kg	1581	*H*	1289	*H*	1197	*H*	906	*H*	422	*H*
Exchangeable Magnesium	mg/kg	241	*H*	212	*H*	178	*H*	141	*H*	93.7	*H*
Exchangeable Potassium	mg/kg	159	*H*	208	*H*	176	*H*	118	*H*	46.6	*H*
Exchangeable Sodium	mg/kg	17.9	*H.Sodic*	12.6	*Sodic*	25.5	*H.Sodic*	56.6	*H.Sodic*	20.7	*H.Sodic*
Exchangeable Aluminium	mg/kg	2.00	*VL*	2	*	2	*	2	*	6.45	*
Exchangeable Calcium	meq/100g	7.91	*M*	6.45	*M*	5.99	*M*	4.53	*L*	2.11	*L*
Exchangeable Magnesium	meq/100g	2.01	*M*	1.77	*M*	1.48	*M*	1.18	*M*	0.78	*L*
Exchangeable Potassium	meq/100g	0.41	*M*	0.53	*M*	0.45	*M*	0.30	*M*	0.12	*VL*
Exchangeable Sodium	meq/100g	0.08	*VL*	0.05	*VL*	0.11	*L*	0.25	*L*	0.09	*VL*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.07	*E*
Calcium/Magnesium Ratio	-	3.9	*Low Ca*	3.6	*Low Ca*	4.0	*Balanced*	3.9	*Low Ca*	2.7	*Low Ca*
Emerson Aggregate	Class	5	*Slaking*	5	*Slaking*	5	*Slaking*	5	*Slaking*	3b	*Slight Disp*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B4: Laboratory analysis data for loam topsoils. Part 3 of 3.

TABLE B4. Laboratory Results Loams														
	Lab No	Mean		LCL	UCL	Std Dev	Count	CI 95%	10%ile		90%ile		Min	Max
	Sample ID			95%	95%			(+/-)						
	Sample Depth													
	Field Texture													
Analyses	Unit													
pH - Water	pH units	6.0	M.acid	5.2	6.8	1.3	10	0.8	4.8	VH.Acid	7.7	L.Alk	4.7	7.7
Electrical Conductivity	dS/m	0.1	L.Sal	0.07	0.19	0.1	10	0.06	0.0	VL.Sal	0.2	M.Sal	0.0	0.3
Chloride	mg/kg	52.7	VL.Sal	27	79	42.0	10	26	19.9	VL.Sal	74.8	VL.Sal	16.5	164.0
Total Nitrogen - Kjeldahl	mg/kg	1066.3	L	859	1274	334.6	10	207	692.7	L	1462.0	L	627.0	1570.0
Total Phosphorus - Nitric/Perchloric	mg/kg	181.2	*	93	270	135.8	9	89	69.1	*	384.2	*	63.7	401.0
Phosphorus - Colwell extr	mg/kg	17.4	*	13	22	6.6	9	4	10.4	*	23.6	*	9.4	30.5
Potassium - Colwell ext	mg/kg	161.3	*	128	194	53.1	10	33	121.2	*	234.3	*	96.0	255.0
Sulphur - KCl	mg/kg	12.5	H	9.52	15.52	4.8	10	3.00	7.7	L	19.7	H	6.7	21.3
Organic Carbon	%	1.3	M	0.93	1.59	0.5	10	0.33	0.8	L	2.0	H	0.7	2.4
Copper	mg/kg	0.5	M	0.35	0.73	0.2	6	0.19	0.3	L	0.7	M	0.2	0.8
Iron	mg/kg	63.5	*	27	100	59.4	10	37	8.3	*	150.3	*	8.0	171.0
Manganese	mg/kg	5.9	M	4.14	7.66	2.8	10	1.76	3.1	M	7.9	M	2.3	12.3
Zinc	mg/kg	0.6	M	0.25	0.89	0.5	10	0.32	0.2	L	1.0	M	0.2	1.9
Boron	mg/kg	0.6	L	0.41	0.82	0.3	10	0.21	0.3	VL	1.0	M	0.2	1.1
Cation Extraction Method	Rayment& Lyons	*	*	*	*	*	*	*	*	*	*	*	*	*
Cation Exchange Capacity	meq/100g	5.4	VL	3.6	7.1	2.8	10	1.8	3.0	VL	9.0	L	2.3	10.4
Ex Calcium Percent	%	56.9	L	43.9	69.9	21.0	10	13.0	31.1	L	74.5	Normal	10.9	75.9
Ex Magnesium Percent	%	15.9	H	11.4	20.3	7.2	10	4.5	7.5	L	23.4	H	2.4	24.6
Ex Potassium Percent	%	5.4	H	3.6	7.1	2.8	10	1.8	3.2	Normal	7.3	H	2.1	12.4
Ex Sodium Percent	%	2.2	N.Sodic	1.3	3.2	1.5	10	0.9	0.7	N.Sodic	4.1	N.Sodic	0.6	4.7
Ex Aluminium Percent	%	19.6	M	2.1	37.2	28.4	10	17.6	0.2	VL	57.1	VH	0.2	83.3
Exchangeable Calcium	mg/kg	676.2	H	352.0	1000.4	523.1	10	324.2	231.7	H	1318.2	H	75.9	1581.0
Exchangeable Magnesium	mg/kg	110.4	H	60.5	160.3	80.5	10	49.9	22.5	H	214.9	H	10.0	241.0
Exchangeable Potassium	mg/kg	108.0	H	69.1	146.8	62.7	10	38.9	44.8	H	179.2	H	28.4	208.0
Exchangeable Sodium	mg/kg	23.4	H.Sodic	13.9	33.0	15.4	10	9.5	10.0	H.Sodic	42.7	H.Sodic	10.0	56.6
Exchangeable Aluminium	mg/kg	62.5	*	4.2	120.8	94.1	10	58.3	2.0	*	215.0	*	2.0	260.0
Exchangeable Calcium	meq/100g	3.4	L	1.8	5.0	2.6	10	1.6	1.2	VL	6.6	M	0.4	7.9
Exchangeable Magnesium	meq/100g	0.9	L	0.5	1.3	0.7	10	0.4	0.2	VL	1.8	M	0.1	2.0
Exchangeable Potassium	meq/100g	0.3	L	0.2	0.4	0.2	10	0.1	0.1	VL	0.5	M	0.1	0.5
Exchangeable Sodium	meq/100g	0.1	L	0.1	0.1	0.1	10	0.0	0.0	VL	0.2	L	0.0	0.2
Exchangeable Aluminium	meq/100g	0.7	E	0.0	1.3	1.0	10	0.6	0.0	VH	2.4	E	0.0	2.9
Calcium/Magnesium Ratio	-	3.9	Low Ca	3.2	4.5	1.0	10	0.6	2.7	Low Ca	4.7	Balanced	2.5	6.3
Emerson Aggregate	Class	5.0	*	*	*	*	*	*	*	*	*	*	*	*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B5: Laboratory analysis data for clay topsoils. Part 1 of 12.

Table B5. Laboratory Results Clays													
	Lab No	230959-4		230959-8		230959-12		230959-16		230959-20		230959-24	
	Sample ID	166		191		165		163		161		156	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	MC		MC		LC		LC		LC		LC	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	8.02	*M.Alk*	8.66	*H.Alk*	9.08	*E.Alk*	8.43	*M.Alk*	8.66	*H.Alk*	9.05	*E.Alk*
Electrical Conductivity	dS/m	1.29	*E.Sal*	0.80	*VH.Sal*	0.23	*M.Sal*	0.36	*M.Sal*	0.40	*M.Sal*	0.21	*M.Sal*
Chloride	mg/kg	2019.0	*E.Sal*	1024.0	*H.Sal*	131.0	*L.Sal*	184.0	*L.Sal*	442.0	*M.Sal*	108.0	*L.Sal*
Total Nitrogen - Kjeldahl	mg/kg	645.0	*L*	517.0	*L*	616.0	*L*	1425.0	*L*	935.0	*L*	919.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	233.0		194.0	*	154.0	*	260.0	*	163.0	*	220.0	*
Phosphorus - Colwell extr	mg/kg	25.4	*L*	<5.00	*L*	5.2	*L*	20.5	*M*	10.1	*L*	8.0	*L*
Potassium - Colwell ext	mg/kg	158.00	*L*	103.00	*VL*	184.00	*M*	181.00	*M*	153.00	*L*	119.00	*VL*
Sulphur - KCl	mg/kg	84.6	*VH*	88.2	*VH*	31.0	*VH*	39.2	*VH*	33.7	*VH*	36.4	*VH*
Organic Carbon	%	0.96	*L*	1.10	*M*	0.93	*L*	1.71	*M*	1.14	*M*	1.37	*M*
Copper	mg/kg	1.11	*M*	1.27	*M*	0.59	*M*	0.79	*M*	0.53	*M*	1.05	*M*
Iron	mg/kg	15.50	*	8.86	*	13.70	*	15.00	*	11.70	*	12.30	*
Manganese	mg/kg	5.06	*M*	5.64	*M*	3.78	*M*	4.92	*M*	6.06	*M*	5.20	*M*
Zinc	mg/kg	0.20	*VL*	0.20	*VL*	<0.20	*L*	0.24	*VL*	<0.20	*L*	<0.20	*L*
Boron	mg/kg	2.55	*H*	2.55	*H*	1.65	*M*	1.45	*M*	1.58	*M*	2.75	*H*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	17.0	*M*	20.5	*	19.2	*	20.6	*	18.1	*	18.6	*
Ex Calcium Percent	%	45.97	*L*	53.70	*	58.63	*	72.23	*	66.20	*	65.01	*
Ex Magnesium Percent	%	36.04	*H*	28.84	*	29.80	*	20.23	*	23.98	*	22.86	*
Ex Potassium Percent	%	1.87	*Normal*	1.10	*	0.77	*	1.61	*	1.41	*	1.45	*
Ex Sodium Percent	%	16.00	*H.Sodic*	16.26	*H.Sodic*	10.69	*Sodic*	5.83	*N.Sodic*	8.29	*Sodic*	10.57	*Sodic*
Ex Aluminium Percent	%	0.13	*VL*	0.11	*VL*	0.12	*VL*	0.11	*VL*	0.12	*VL*	0.12	*VL*
Exchangeable Calcium	mg/kg	1567	*H*	2200	*H*	2256	*H*	2975	*H*	2397	*H*	2413	*H*
Exchangeable Magnesium	mg/kg	737	*H*	709	*H*	688	*H*	500	*H*	521	*H*	509	*H*
Exchangeable Potassium	mg/kg	124	*H*	87.7	*H*	57.7	*H*	129	*H*	99.7	*H*	105	*H*
Exchangeable Sodium	mg/kg	627	*FALSE*	766	*FALSE*	473	*FALSE*	276	*FALSE*	345	*FALSE*	451	*FALSE*
Exchangeable Aluminium	mg/kg	2.0	*VL*	2.0	*VL*	2.0	*VL*	2.0	*VL*	2.0	*VL*	2.0	*VL*
Exchangeable Calcium	meq/100g	7.84	*M*	11.00	*H*	11.28	*H*	14.88	*H*	11.99	*H*	12.07	*H*
Exchangeable Magnesium	meq/100g	6.14	*H*	5.91	*H*	5.73	*H*	4.17	*H*	4.34	*H*	4.24	*H*
Exchangeable Potassium	meq/100g	0.32	*M*	0.22	*L*	0.15	*VL*	0.33	*M*	0.26	*L*	0.27	*L*
Exchangeable Sodium	meq/100g	2.73	*VH*	3.33	*VH*	2.06	*VH*	1.20	*H*	1.50	*H*	1.96	*H*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	1.3	*Low Ca*	1.9	*Low Ca*	2.0	*Low Ca*	3.6	*Low Ca*	2.8	*Low Ca*	2.8	*Low Ca*
Emerson Aggregate	Class	6.0	*Slaking*	6.0	*Slaking*	4.0	*Slaking*	5.0	*Slaking*	4.0	*Slaking*	4.0	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B5: Laboratory analysis data for clay **top**soils. Part 2 of 12.

Table B5. Laboratory Results Clays													
	Lab No	230959-28		230959-32		230959-36		230959-40		230959-44		230959-48	
	Sample ID	157		152		130		126		124		123	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LC		LC		LC		HC		LMC		ZCL	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	8.49	*M.Alk*	8.54	*H.Alk*	8.76	*H.Alk*	8.48	*M.Alk*	8.59	*H.Alk*	8.52	*H.Alk*
Electrical Conductivity	dS/m	0.6	*H.Sal*	0.35	*M.Sal*	0.39	*M.Sal*	0.39	*M.Sal*	0.27	*M.Sal*	0.23	*M.Sal*
Chloride	mg/kg	658.0	*H.Sal*	181.0	*L.Sal*	421.0	*M.Sal*	395.0	*M.Sal*	171.0	*L.Sal*	34.8	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	747.0	*L*	1008.0	*L*	894.0	*L*	1020.0	*L*	1292.0	*L*	885.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	263.0	*	228.0	*	233.0	*	199.0	*	231.0	*	210.0	*
Phosphorus - Colwell extr	mg/kg	<5.00		9.04	*L*	<5.00		<5.00	*L*	15.6	*L*	<5.00	*L*
Potassium - Colwell ext	mg/kg	119.00	*VL*	123.00	*L*	106.00	*VL*	165.00	*L*	157.00	*L*	172.00	*M*
Sulphur - KCl	mg/kg	69.1	*VH*	44.6	*VH*	42.0	*VH*	36.5	*VH*	29.3	*VH*	22.2	*VH*
Organic Carbon	%	1.15	*M*	1.28	*M*	1.22	*M*	1.54	*M*	1.54	*M*	1.33	*M*
Copper	mg/kg	0.81	*M*	1.21	*M*	0.81	*M*	0.77	*M*	1.09	*M*	0.53	*M*
Iron	mg/kg	12.00	*	15.10	*	14.80	*	14.80	*	14.70	*	13.10	*
Manganese	mg/kg	4.06	*M*	8.16	*M*	3.92	*M*	5.52	*M*	6.16	*M*	6.86	*M*
Zinc	mg/kg	0.22	*VL*	0.20	*VL*	<0.20	*L*	<0.20	*L*	3.32	*M*	0.22	*VL*
Boron	mg/kg	2.80	*H*	1.65	*M*	2.50	*H*	2.30	*H*	3.00	*H*	1.60	*M*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	18.2	*	20.5	*	14.3	*	14.3	*	16.4	*	12.1	*
Ex Calcium Percent	%	57.88	*	67.26	*	59.79	*	63.12	*	64.35	*	71.73	*
Ex Magnesium Percent	%	27.34	*	24.09	*	26.61	*	26.40	*	26.69	*	20.34	*
Ex Potassium Percent	%	1.54	*	1.18	*	1.46	*	1.70	*	1.88	*	2.08	*
Ex Sodium Percent	%	13.12	*Sodic*	7.36	*Sodic*	11.99	*Sodic*	8.62	*Sodic*	6.95	*Sodic*	5.66	*N.Sodic*
Ex Aluminium Percent	%	0.12	*VL*	0.11	*VL*	0.16	*VL*	0.16	*VL*	0.14	*VL*	0.18	*VL*
Exchangeable Calcium	mg/kg	2106	*H*	2764	*H*	1704	*H*	1801	*H*	2110	*H*	1740	*H*
Exchangeable Magnesium	mg/kg	597	*H*	594	*H*	455	*H*	452	*H*	525	*H*	296	*H*
Exchangeable Potassium	mg/kg	109	*H*	94.5	*H*	81.2	*H*	94.5	*H*	120	*H*	98.6	*H*
Exchangeable Sodium	mg/kg	549	*FALSE*	348	*FALSE*	393	*FALSE*	283	*FALSE*	262	*FALSE*	158	*FALSE*
Exchangeable Aluminium	mg/kg	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*VL*
Exchangeable Calcium	meq/100g	10.53	*H*	13.82	*H*	8.52	*M*	9.01	*M*	10.55	*H*	8.70	*M*
Exchangeable Magnesium	meq/100g	4.98	*H*	4.95	*H*	3.79	*H*	3.77	*H*	4.38	*H*	2.47	*M*
Exchangeable Potassium	meq/100g	0.28	*L*	0.24	*L*	0.21	*L*	0.24	*L*	0.31	*M*	0.25	*L*
Exchangeable Sodium	meq/100g	2.39	*VH*	1.51	*H*	1.71	*H*	1.23	*H*	1.14	*H*	0.69	*M*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	2.1	*Low Ca*	2.8	*Low Ca*	2.2	*Low Ca*	2.4	*Low Ca*	2.4	*Low Ca*	3.5	*Low Ca*
Emerson Aggregate	Class	4	*Slaking*	4	*Slaking*	4	*Slaking*	5	*Slaking*	4	*Slaking*	7	*Stable*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B5: Laboratory analysis data for clay topsoils. Part 3 of 12.

Table B5. Laboratory Results Clays													
	Lab No	230959-56		230959-60		230959-64		230959-68		230959-72		230959-76	
	Sample ID	314		111		108		270		93		291	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LC		LC		LMC		LC		LC		LMC	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	8.61	*H.Alk*	8.2	*M.Alk*	8.5	*H.Alk*	9.02	*E.Alk*	8.01	*M.Alk*	8.65	*H.Alk*
Electrical Conductivity	dS/m	0.17	*L.Sal*	0.32	*M.Sal*	0.29	*M.Sal*	0.44	*M.Sal*	0.44	*M.Sal*	0.2	*M.Sal*
Chloride	mg/kg	84.0	*VL.Sal*	370.0	*M.Sal*	215.0	*L.Sal*	454.0	*M.Sal*	63.2	*VL.Sal*	125.0	*L.Sal*
Total Nitrogen - Kjeldahl	mg/kg	1165.0	*L*	742.0	*L*	771.0	*L*	830.0	*L*	1630.0	*M*	1196.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	230.0	*	189.0	*	135.0	*	337.0	*	258.0	*	194.0	*
Phosphorus - Colwell extr	mg/kg	<5.00	*L*	<5.00	*L*	<5.00	*L*	<5.00	*L*	<5.00	*L*	19.4	*L*
Potassium - Colwell ext	mg/kg	176.00	*L*	111.00	*VL*	123.00	*L*	229.00	*M*	226.00	*M*	218.00	*M*
Sulphur - KCl	mg/kg	19.5	*H*	24.9	*VH*	21.7	*VH*	43.8	*VH*	57.3	*VH*	24.1	*VH*
Organic Carbon	%	1.69	*M*	1.13	*M*	1.23	*M*	1.38	*M*	3.24	*VH*	1.73	*M*
Copper	mg/kg	0.73	*M*	0.55	*M*	0.43	*M*	0.97	*M*	0.55	*M*	0.79	*M*
Iron	mg/kg	13.70	*	13.50	*	15.60	*	14.80	*	15.60	*	18.10	*
Manganese	mg/kg	6.82	*M*	6.48	*M*	6.14	*M*	5.62	*M*	5.76	*M*	5.20	*M*
Zinc	mg/kg	0.26	*VL*	<0.20	*L*	<0.20	*L*	<0.20	*L*	0.26	*VL*	0.20	*VL*
Boron	mg/kg	1.45	*M*	1.48	*M*	1.85	*M*	2.45	*H*	1.35	*M*	1.60	*M*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	15.1	*	14.7	*	25.7	*	18.4	*	18.5	*	19.0	*
Ex Calcium Percent	%	66.37	*	67.53	*	60.02	*	57.33	*	80.26	*	66.54	*
Ex Magnesium Percent	%	24.30	*	22.24	*	29.91	*	26.05	*	15.39	*	24.53	*
Ex Potassium Percent	%	2.45	*	1.46	*	0.83	*	1.85	*	1.86	*	2.21	*
Ex Sodium Percent	%	6.74	*Sodic*	8.62	*Sodic*	9.15	*Sodic*	14.65	*H.Sodic*	2.37	*N.Sodic*	6.60	*Sodic*
Ex Aluminium Percent	%	0.15	*VL*	0.15	*VL*	0.09	*VL*	0.12	*VL*	0.12	*VL*	0.12	*VL*
Exchangeable Calcium	mg/kg	2003	*H*	1989	*H*	3080	*H*	2113	*H*	2973	*H*	2532	*H*
Exchangeable Magnesium	mg/kg	440	*H*	393	*H*	921	*H*	576	*H*	342	*H*	560	*H*
Exchangeable Potassium	mg/kg	144	*H*	84	*H*	83.5	*H*	133	*H*	134	*H*	164	*H*
Exchangeable Sodium	mg/kg	234	*FALSE*	292	*FALSE*	540	*FALSE*	621	*FALSE*	101	*FALSE*	289	*FALSE*
Exchangeable Aluminium	mg/kg	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*VL*
Exchangeable Calcium	meq/100g	10.02	*H*	9.95	*M*	15.40	*H*	10.57	*H*	14.87	*H*	12.66	*H*
Exchangeable Magnesium	meq/100g	3.67	*H*	3.28	*H*	7.68	*H*	4.80	*H*	2.85	*M*	4.67	*H*
Exchangeable Potassium	meq/100g	0.37	*M*	0.22	*L*	0.21	*L*	0.34	*M*	0.34	*M*	0.42	*M*
Exchangeable Sodium	meq/100g	1.02	*H*	1.27	*H*	2.35	*VH*	2.70	*VH*	0.44	*M*	1.26	*H*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	2.7	*Low Ca*	3.0	*Low Ca*	2.0	*Low Ca*	2.2	*Low Ca*	5.2	*Balanced*	2.7	*Low Ca*
Emerson Aggregate	Class	4	*Slaking*	5	*Slaking*	5	*Slaking*	4	*Slaking*	4	*Slaking*	5	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B5: Laboratory analysis data for clay topsoils. Part 4 of 12.

Table B5. Laboratory Results Clays													
	Lab No	230959-80		230959-84		230959-88		230959-92		230959-96		230959-100	
	Sample ID	291 (b)		86		81		82		73		67	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	HC		CL		LC		LC		LC		LMC	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	8.93	*H.Alk*	8.3	*M.Alk*	7.15	*Neutral*	8.58	*H.Alk*	8.89	*H.Alk*	8.72	*H.Alk*
Electrical Conductivity	dS/m	0.44	*M.Sal*	0.28	*M.Sal*	0.13	*L.Sal*	0.29	*M.Sal*	0.17	*L.Sal*	0.46	*H.Sal*
Chloride	mg/kg	456.0	*M.Sal*	58.8	*VL.Sal*	73.7	*VL.Sal*	280.0	*L.Sal*	60.6	*VL.Sal*	444.0	*M.Sal*
Total Nitrogen - Kjeldahl	mg/kg	710.0	*L*	1420.0	*L*	784.0	*L*	1052.0	*L*	816.0	*L*	1050.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	213.0	*	252.0	*	223.0	*	247.0	*	161.0	*	242.0	*
Phosphorus - Colwell extr	mg/kg	<5.00	*L*	5.76	*L*	69.9	*H*	<5.00	*L*	<5.00	*L*	<5.00	*L*
Potassium - Colwell ext	mg/kg	111.00	*VL*	241.00	*M*	136.00	*L*	228.00	*M*	110.00	*VL*	130.00	*L*
Sulphur - KCl	mg/kg	38.0	*VH*	28.0	*VH*	13.1	*H*	26.8	*VH*	24.2	*VH*	51.7	*VH*
Organic Carbon	%	1.22	*M*	2.19	*H*	1.06	*M*	1.53	*M*	1.21	*M*	1.17	*M*
Copper	mg/kg	0.55	*M*	0.77	*M*	0.91	*M*	0.77	*M*	0.81	*M*	1.1	*M*
Iron	mg/kg	15.20	*	19.20	*	27.40	*	15.50	*	14.50	*	6.68	*
Manganese	mg/kg	3.74	*M*	6.56	*M*	10.40	*M*	5.99	*M*	6.60	*M*	5.81	*M*
Zinc	mg/kg	<0.20	*L*	0.28	*VL*	0.34	*L*	0.22	*VL*	<0.20	*L*	0.27	*VL*
Boron	mg/kg	3.15	*H*	1.60	*M*	1.90	*M*	1.85	*M*	1.65	*M*	1.28	*M*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15A1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	21.0	*	18.5	*	17.7	*M*	18.2	*	20.9	*	28.9	*
Ex Calcium Percent	%	56.51	*	70.67	*	60.96	*L*	66.19	*	64.79	*	61.25	*
Ex Magnesium Percent	%	27.00	*	22.56	*	31.29	*H*	23.71	*	26.13	*	27.72	*
Ex Potassium Percent	%	0.88	*	2.33	*	1.79	*Normal*	1.93	*	1.08	*	0.90	*
Ex Sodium Percent	%	15.49	*H.Sodic*	4.31	*N.Sodic*	5.8	*N.Sodic*	8.05	*Sodic*	7.90	*Sodic*	10.05	*Sodic*
Ex Aluminium Percent	%	0.11	*VL*	0.12	*VL*	0.13	*VL*	0.12	*VL*	0.11	*VL*	0.08	*VL*
Exchangeable Calcium	mg/kg	2379	*H*	2610	*H*	2163	*H*	2410	*H*	2711	*H*	3539	*H*
Exchangeable Magnesium	mg/kg	682	*H*	500	*H*	666	*H*	518	*H*	656	*H*	961	*H*
Exchangeable Potassium	mg/kg	72.6	*H*	168	*H*	124	*H*	137	*H*	87.8	*H*	101	*H*
Exchangeable Sodium	mg/kg	750	*FALSE*	183	*FALSE*	238	*FALSE*	337	*FALSE*	380	*FALSE*	668	*FALSE*
Exchangeable Aluminium	mg/kg	2	*VL*	2	*VL*	2.00	*VL*	2	*VL*	2	*VL*	2	*VL*
Exchangeable Calcium	meq/100g	11.90	*H*	13.05	*H*	10.82	*H*	12.05	*H*	13.56	*H*	17.70	*H*
Exchangeable Magnesium	meq/100g	5.68	*H*	4.17	*H*	5.55	*H*	4.32	*H*	5.47	*H*	8.01	*VH*
Exchangeable Potassium	meq/100g	0.19	*VL*	0.43	*M*	0.32	*M*	0.35	*M*	0.23	*L*	0.26	*L*
Exchangeable Sodium	meq/100g	3.26	*VH*	0.80	*H*	1.03	*H*	1.47	*H*	1.65	*H*	2.90	*VH*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	2.1	*Low Ca*	3.1	*Low Ca*	1.9	*Low Ca*	2.8	*Low Ca*	2.5	*Low Ca*	2.2	*Low Ca*
Emerson Aggregate	Class	4	*Slaking*	5	*Slaking*	3b	*Slight Disp.*	4	*Slaking*	4	*Slaking*	4	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B5: Laboratory analysis data for clay topsoils. Part 5 of 12.

Table B5. Laboratory Results Clays													
	Lab No	230959-104		230959-108		230959-112		230959-116		230959-136		230959-140	
	Sample ID	71		69		61		61 (b)		48		284	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LMC		LMC		LMC		LMC		LMC		LMC	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	8.43	*M.Alk*	8.87	*H.Alk*	8.74	*H.Alk*	8.75	*H.Alk*	6.67	*Neutral*	8.09	*M.Alk*
Electrical Conductivity	dS/m	0.19	*M.Sal*	0.21	*M.Sal*	0.35	*M.Sal*	0.36	*M.Sal*	0.21	*M.Sal*	0.44	*M.Sal*
Chloride	mg/kg	99.5	*VL.Sal*	81.1	*VL.Sal*	315.0	*M.Sal*	343.0	*M.Sal*	49.2	*VL.Sal*	280.0	*L.Sal*
Total Nitrogen - Kjeldahl	mg/kg	1260.0	*L*	1010.0	*L*	1230.0	*L*	1330.0	*L*	1310.0	*L*	1410.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	138.0	*	163.0	*	213.0	*	190.0	*	259.0	*	340.0	*
Phosphorus - Colwell extr	mg/kg	<5.00	*L*	<5.00	*L*	6.26	*L*	5.37	*L*	18.7	*L*	11.1	*L*
Potassium - Colwell ext	mg/kg	118.00	*VL*	154.00	*L*	148.00	*L*	136.00	*L*	207.00	*M*	192.00	*M*
Sulphur - KCl	mg/kg	7.6	*L*	11.0	*M*	12.3	*H*	11.5	*M*	12.0	*H*	26.8	*VH*
Organic Carbon	%	1.28	*M*	0.95	*L*	1.1	*M*	1.43	*M*	0.92	*L*	1.37	*M*
Copper	mg/kg	1.23	*M*	0.85	*M*	0.89	*M*	0.83	*M*	0.85	*M*	0.95	*M*
Iron	mg/kg	7.70	*	5.12	*	2.82	*	3.94	*	17.60	*	6.70	*
Manganese	mg/kg	13.80	*M*	7.22	*M*	5.04	*M*	5.16	*M*	15.00	*M*	7.28	*M*
Zinc	mg/kg	1.60	*M*	0.22	*VL*	<0.20	*L*	0.26	*VL*	0.42	*L*	0.62	*L*
Boron	mg/kg	0.96	*L*	0.98	*L*	0.64	*L*	1.34	*M*	1.06	*M*	1.36	*M*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15A1	*	15C1	*
Cation Exchange Capacity	meq/100g	28.9	*	25.2	*	25.4	*	25.5	*	13.9	*M*	19.0	*
Ex Calcium Percent	%	67.80	*	66.64	*	67.76	*	63.59	*	59.43	*L*	70.95	*
Ex Magnesium Percent	%	26.02	*	25.83	*	22.21	*	24.90	*	32.88	*H*	20.95	*
Ex Potassium Percent	%	0.86	*	0.69	*	1.44	*	1.26	*	2.23	*Normal*	2.47	*
Ex Sodium Percent	%	5.25	*N.Sodic*	6.75	*Sodic*	8.49	*Sodic*	10.16	*Sodic*	5.3	*N.Sodic*	5.51	*
Ex Aluminium Percent	%	0.08	*VL*	0.09	*VL*	0.09	*VL*	0.09	*VL*	0.16	*VL*	0.12	*VL*
Exchangeable Calcium	mg/kg	3918	*H*	3363	*H*	3442	*H*	3243	*H*	1657	*H*	2698	*H*
Exchangeable Magnesium	mg/kg	902	*H*	782	*H*	677	*H*	762	*H*	550	*H*	478	*H*
Exchangeable Potassium	mg/kg	96.4	*H*	67.9	*H*	143	*H*	125	*H*	121	*H*	183	*H*
Exchangeable Sodium	mg/kg	349	*FALSE*	392	*FALSE*	496	*FALSE*	596	*FALSE*	170	*FALSE*	241	*FALSE*
Exchangeable Aluminium	mg/kg	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2.00	*VL*	2	*VL*
Exchangeable Calcium	meq/100g	19.59	*H*	16.82	*H*	17.21	*H*	16.22	*H*	8.29	*M*	13.49	*H*
Exchangeable Magnesium	meq/100g	7.52	*H*	6.52	*H*	5.64	*H*	6.35	*H*	4.58	*H*	3.98	*H*
Exchangeable Potassium	meq/100g	0.25	*L*	0.17	*VL*	0.37	*M*	0.32	*M*	0.31	*M*	0.47	*M*
Exchangeable Sodium	meq/100g	1.52	*H*	1.70	*H*	2.16	*VH*	2.59	*VH*	0.74	*H*	1.05	*H*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	2.6	*Low Ca*	2.6	*Low Ca*	3.1	*Low Ca*	2.6	*Low Ca*	1.8	*Low Ca*	3.4	*Low Ca*
Emerson Aggregate	Class	5	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*	5	*Slaking*	5	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B5: Laboratory analysis data for clay topsoils. Part 6 of 12.

Table B5. Laboratory Results Clays													
	Lab No	230959-160		230959-164		230959-168		230959-172		230959-180		230959-184	
	Sample ID	255		210		102		103		216		188	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LMC		LMC		LMC		LC		MC		MC	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	8.92	*H.Alk*	8.73	*H.Alk*	8.73	*H.Alk*	9.2	*E.Alk*	8.76	*H.Alk*	8.58	*H.Alk*
Electrical Conductivity	dS/m	0.15	*L.Sal*	0.37	*M.Sal*	0.19	*M.Sal*	0.13	*L.Sal*	0.26	*M.Sal*	0.38	*M.Sal*
Chloride	mg/kg	67.5	*VL.Sal*	196.0	*L.Sal*	83.0	*VL.Sal*	13.1	*VL.Sal*	81.4	*VL.Sal*	257.0	*L.Sal*
Total Nitrogen - Kjeldahl	mg/kg	1450.0	*L*	1330.0	*L*	1310.0	*L*	922.0	*L*	1400.0	*L*	1540.0	*M*
Total Phosphorus - Nitric/Perchloric	mg/kg	529.0	*	296.0	*	357.0	*	525.0	*	277.0	*	231.0	*
Phosphorus - Colwell extr	mg/kg	49.3	*M*	7.14	*L*	11.6	*L*	8.47	*L*	12	*L*	8.91	*L*
Potassium - Colwell ext	mg/kg	173.00	*L*	161.00	*L*	142.00	*L*	130.00	*L*	180.00	*M*	120.00	*L*
Sulphur - KCl	mg/kg	9.2	*M*	80.0	*VH*	14.8	*H*	11.7	*M*	17.0	*H*	17.5	*H*
Organic Carbon	%	1.41	*M*	1.84	*H*	1.56	*M*	1.74	*M*	1.26	*M*	1.66	*M*
Copper	mg/kg	0.97	*M*	0.91	*M*	0.41	*M*	0.67	*M*	0.97	*M*	1.03	*M*
Iron	mg/kg	11.00	*	8.14	*	6.02	*	3.14	*	5.78	*	3.66	*
Manganese	mg/kg	6.10	*M*	5.20	*M*	4.72	*M*	3.94	*M*	5.48	*M*	4.36	*M*
Zinc	mg/kg	0.34	*L*	<0.20	*L*	<0.20	*L*	0.44	*L*	0.46	*L*	0.30	*L*
Boron	mg/kg	0.76	*L*	1.68	*M*	0.76	*L*	0.88	*L*	1.74	*M*	1.92	*M*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	22.0	*	38.6	*	27.1	*	20.8	*	36.4	*	36.8	*
Ex Calcium Percent	%	69.77	*	71.99	*	72.55	*	58.47	*	71.60	*	71.38	*
Ex Magnesium Percent	%	21.80	*	18.90	*	22.48	*	35.64	*	21.82	*	22.53	*
Ex Potassium Percent	%	1.64	*	0.95	*	1.11	*	0.94	*	1.25	*	0.80	*
Ex Sodium Percent	%	6.68	*Sodic*	8.10	*Sodic*	3.78	*N.Sodic*	4.84	*N.Sodic*	5.27	*N.Sodic*	5.23	*N.Sodic*
Ex Aluminium Percent	%	0.10	*VL*	0.06	*VL*	0.08	*VL*	0.11	*VL*	0.06	*VL*	0.06	*VL*
Exchangeable Calcium	mg/kg	3068	*H*	5560	*H*	3937	*H*	2428	*H*	5218	*H*	5248	*H*
Exchangeable Magnesium	mg/kg	575	*H*	876	*H*	732	*H*	888	*H*	954	*H*	994	*H*
Exchangeable Potassium	mg/kg	141	*H*	143	*H*	117	*H*	76.2	*H*	177	*H*	114	*H*
Exchangeable Sodium	mg/kg	338	*FALSE*	719	*FALSE*	236	*FALSE*	231	*FALSE*	442	*FALSE*	442	*FALSE*
Exchangeable Aluminium	mg/kg	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*VL*
Exchangeable Calcium	meq/100g	15.34	*H*	27.80	*VH*	19.69	*H*	12.14	*H*	26.09	*VH*	26.24	*VH*
Exchangeable Magnesium	meq/100g	4.79	*H*	7.30	*H*	6.10	*H*	7.40	*H*	7.95	*H*	8.28	*VH*
Exchangeable Potassium	meq/100g	0.36	*M*	0.37	*M*	0.30	*M*	0.20	*VL*	0.45	*M*	0.29	*L*
Exchangeable Sodium	meq/100g	1.47	*H*	3.13	*VH*	1.03	*H*	1.00	*H*	1.92	*H*	1.92	*H*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	3.2	*Low Ca*	3.8	*Low Ca*	3.2	*Low Ca*	1.6	*Low Ca*	3.3	*Low Ca*	3.2	*Low Ca*
Emerson Aggregate	Class	3b	*Slight Disp.*	4	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B5: Laboratory analysis data for clay soils. Part 7 of 12.

Table B5. Laboratory Results Clays													
	Lab No	230959-188		230959-192		230959-204		230959-208		230959-216		230959-220	
	Sample ID	145		148		231a		231b		275		278	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	MC		MC		LMC		LMC		LMC		LMC	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	8.63	*H.Alk*	8.83	*H.Alk*	8.67	*H.Alk*	8.46	*M.Alk*	8.74	*H.Alk*	8.47	*M.Alk*
Electrical Conductivity	dS/m	0.29	*M.Sal*	0.23	*M.Sal*	0.35	*M.Sal*	0.3	*M.Sal*	0.49	*H.Sal*	0.22	*M.Sal*
Chloride	mg/kg	153.0	*L.Sal*	162.0	*L.Sal*	409.0	*M.Sal*	214.0	*L.Sal*	523.0	*M.Sal*	82.6	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	1670.0	*M*	1460.0	*L*	2070.0	*M*	2290.0	*M*	1670.0	*M*	2010.0	*M*
Total Phosphorus - Nitric/Perchloric	mg/kg	231.0	*	247.0	*	243.0	*	521.0	*	332.0	*	274.0	*
Phosphorus - Colwell extr	mg/kg	5.32	*L*	12	*L*	24.6	*L*	38.2	*M*	20.1	*L*	14.2	*L*
Potassium - Colwell ext	mg/kg	177.00	*L*	123.00	*L*	184.00	*M*	263.00	*M*	201.00	*M*	256.00	*M*
Sulphur - KCl	mg/kg	33.6	*VH*	20.7	*VH*	15.3	*H*	26.9	*VH*	30.0	*VH*	13.8	*H*
Organic Carbon	%	1.73	*M*	1.41	*M*	2.27	*H*	2.49	*H*	1.41	*M*	2.04	*H*
Copper	mg/kg	0.82	*M*	0.83	*M*	0.47	*M*	0.43	*M*	0.91	*M*	0.81	*M*
Iron	mg/kg	6.13	*	7.18	*	5.73	*	5.30	*	7.50	*	6.65	*
Manganese	mg/kg	7.58	*M*	4.70	*M*	5.75	*M*	5.08	*M*	12.10	*M*	6.15	*M*
Zinc	mg/kg	0.38	*L*	0.28	*VL*	0.43	*L*	0.45	*L*	0.58	*L*	0.58	*L*
Boron	mg/kg	1.75	*M*	1.84	*M*	1.83	*M*	1.75	*M*	1.59	*M*	1.19	*M*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	31.3	*	20.3	*	20.7	*	16.8	*	17.8	*	18.3	*
Ex Calcium Percent	%	75.15	*	64.06	*	68.32	*	73.77	*	65.00	*	70.39	*
Ex Magnesium Percent	%	17.95	*	26.68	*	20.86	*	19.20	*	21.40	*	23.27	*
Ex Potassium Percent	%	1.51	*	1.65	*	2.02	*	3.39	*	2.38	*	2.87	*
Ex Sodium Percent	%	5.32	*N.Sodic*	7.50	*Sodic*	8.70	*Sodic*	3.51	*N.Sodic*	11.09	*Sodic*	3.34	*N.Sodic*
Ex Aluminium Percent	%	0.07	*VL*	0.11	*VL*	0.11	*VL*	0.13	*VL*	0.12	*VL*	0.12	*VL*
Exchangeable Calcium	mg/kg	4709	*H*	2601	*H*	2833	*H*	2485	*H*	2313	*H*	2581	*H*
Exchangeable Magnesium	mg/kg	675	*H*	650	*H*	519	*H*	388	*H*	457	*H*	512	*H*
Exchangeable Potassium	mg/kg	184	*H*	131	*H*	163	*H*	223	*H*	165	*H*	205	*H*
Exchangeable Sodium	mg/kg	383	*FALSE*	350	*FALSE*	415	*FALSE*	136	*FALSE*	454	*FALSE*	141	*FALSE*
Exchangeable Aluminium	mg/kg	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*VL*
Exchangeable Calcium	meq/100g	23.55	*VH*	13.01	*H*	14.17	*H*	12.43	*H*	11.57	*H*	12.91	*H*
Exchangeable Magnesium	meq/100g	5.63	*H*	5.42	*H*	4.33	*H*	3.23	*H*	3.81	*H*	4.27	*H*
Exchangeable Potassium	meq/100g	0.47	*M*	0.34	*M*	0.42	*M*	0.57	*M*	0.42	*M*	0.53	*M*
Exchangeable Sodium	meq/100g	1.67	*H*	1.52	*H*	1.80	*H*	0.59	*M*	1.97	*H*	0.61	*M*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	4.2	*Balanced*	2.4	*Low Ca*	3.3	*Low Ca*	3.8	*Low Ca*	3.0	*Low Ca*	3.0	*Low Ca*
Emerson Aggregate	Class	5	*Slaking*	5	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*	5	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B5: Laboratory analysis data for clay soils. Part 8 of 12.

Table B5. Laboratory Results Clays													
	Lab No	230959-224		230959-228		230959-232		230959-236		230959-240		230959-244	
	Sample ID	68		72		232		62		250		248	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LMC		LMC		MC		MC		MC		LMC	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	9.29	*E.Alk*	8.42	*M.Alk*	8.45	*M.Alk*	9.03	*E.Alk*	8.69	*H.Alk*	8.84	*H.Alk*
Electrical Conductivity	dS/m	0.32	*M.Sal*	0.37	*M.Sal*	0.4	*M.Sal*	0.48	*H.Sal*	0.26	*M.Sal*	0.27	*M.Sal*
Chloride	mg/kg	410.0	*M.Sal*	175.0	*L.Sal*	226.0	*L.Sal*	532.0	*M.Sal*	72.9	*VL.Sal*	200.0	*L.Sal*
Total Nitrogen - Kjeldahl	mg/kg	500.0	*L*	1540.0	*M*	1450.0	*L*	920.0	*L*	1230.0	*L*	1090.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	224.0	*	203.0	*	201.0	*	191.0	*	142.0	*	149.0	*
Phosphorus - Colwell extr	mg/kg	8.1	*L*	17.4	*L*	13.4	*L*	7.14	*L*	9.8	*L*	19.6	*L*
Potassium - Colwell ext	mg/kg	105.00	*VL*	167.00	*L*	162.00	*L*	132.00	*L*	190.00	*M*	143.00	*L*
Sulphur - KCl	mg/kg	27.1	*VH*	20.0	*VH*	31.3	*VH*	15.0	*H*	14.7	*H*	21.2	*VH*
Organic Carbon	%	0.43	*VL*	1.28	*M*	1.35	*M*	0.87	*L*	1.26	*M*	1.19	*M*
Copper	mg/kg	0.57	*M*	0.81	*M*	0.87	*M*	0.81	*M*	0.63	*M*	0.69	*M*
Iron	mg/kg	7.55	*	5.40	*	6.45	*	8.43	*	7.43	*	7.03	*
Manganese	mg/kg	5.58	*M*	12.30	*M*	4.55	*M*	5.30	*M*	3.43	*M*	4.13	*M*
Zinc	mg/kg	<0.20	*L*	0.63	*L*	0.35	*L*	0.28	*VL*	0.25	*VL*	<0.20	*L*
Boron	mg/kg	1.69	*M*	1.33	*M*	1.69	*M*	2.41	*H*	2.95	*H*	1.99	*M*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	12.5	*	18.6	*	18.9	*	19.3	*	25.3	*	19.8	*
Ex Calcium Percent	%	55.12	*	65.78	*	68.74	*	54.07	*	67.87	*	66.09	*
Ex Magnesium Percent	%	26.79	*	26.41	*	23.47	*	28.24	*	24.54	*	23.99	*
Ex Potassium Percent	%	2.13	*	1.99	*	2.19	*	1.59	*	1.76	*	1.88	*
Ex Sodium Percent	%	15.78	*H.Sodic*	5.69	*N.Sodic*	5.49	*N.Sodic*	15.97	*H.Sodic*	5.75	*N.Sodic*	7.93	*Sodic*
Ex Aluminium Percent	%	0.18	*VL*	0.12	*VL*	0.12	*VL*	0.12	*VL*	0.09	*VL*	0.11	*VL*
Exchangeable Calcium	mg/kg	1382	*H*	2441	*H*	2592	*H*	2087	*H*	3430	*H*	2617	*H*
Exchangeable Magnesium	mg/kg	403	*H*	588	*H*	531	*H*	654	*H*	744	*H*	570	*H*
Exchangeable Potassium	mg/kg	104	*H*	144	*H*	161	*H*	120	*H*	173	*H*	145	*H*
Exchangeable Sodium	mg/kg	455	*FALSE*	243	*FALSE*	238	*FALSE*	709	*FALSE*	334	*FALSE*	361	*FALSE*
Exchangeable Aluminium	mg/kg	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*VL*
Exchangeable Calcium	meq/100g	6.91	*M*	12.21	*H*	12.96	*H*	10.44	*H*	17.15	*H*	13.09	*H*
Exchangeable Magnesium	meq/100g	3.36	*H*	4.90	*H*	4.43	*H*	5.45	*H*	6.20	*H*	4.75	*H*
Exchangeable Potassium	meq/100g	0.27	*L*	0.37	*M*	0.41	*M*	0.31	*M*	0.44	*M*	0.37	*M*
Exchangeable Sodium	meq/100g	1.98	*H*	1.06	*H*	1.03	*H*	3.08	*VH*	1.45	*H*	1.57	*H*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	2.1	*Low Ca*	2.5	*Low Ca*	2.9	*Low Ca*	1.9	*Low Ca*	2.8	*Low Ca*	2.8	*Low Ca*
Emerson Aggregate	Class	3b	*Slight Disp*	5	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B5: Laboratory analysis data for clay soils. Part 9 of 12.

Table B5. Laboratory Results Clays													
	Lab No	230959-248		230959-252		230959-256		230959-260		230959-284		230959-288	
	Sample ID	57		55		285		52		268c		283	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LMC		LMC		LMC		LMC		LMC		HC	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	8.9	*H.Alk*	9.02	*E.Alk*	8.44	*M.Alk*	7.99	*M.Alk*	8.88	*H.Alk*	8.55	*H.Alk*
Electrical Conductivity	dS/m	0.61	*H.Sal*	0.33	*M.Sal*	0.24	*M.Sal*	0.31	*M.Sal*	0.37	*M.Sal*	0.45	*H.Sal*
Chloride	mg/kg	760.0	*H.Sal*	230.0	*L.Sal*	62.3	*VL.Sal*	53.5	*VL.Sal*	365.0	*M.Sal*	405.0	*M.Sal*
Total Nitrogen - Kjeldahl	mg/kg	1070.0	*L*	960.0	*L*	1690.0	*M*	2340.0	*M*	1290.0	*L*	1370.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	150.0	*	103.0	*	287.0	*	499.0	*	147.0	*	227.0	*
Phosphorus - Colwell extr	mg/kg	6.26	*L*	<5.00	*L*	17.8	*L*	125	*H*	32.7	*M*	13	*L*
Potassium - Colwell ext	mg/kg	142.00	*L*	155.00	*L*	159.00	*L*	1660.00	*VH*	154.00	*L*	180.00	*M*
Sulphur - KCl	mg/kg	17.6	*H*	10.0	*M*	11.9	*M*	24.3	*VH*	7.5	*L*	21.5	*VH*
Organic Carbon	%	0.88	*L*	0.93	*L*	1.73	*M*	1.48	*M*	1.26	*M*	1.23	*M*
Copper	mg/kg	0.99	*M*	1.53	*M*	0.82	*M*	0.86	*M*	0.71	*M*	0.8	*M*
Iron	mg/kg	7.60	*	10.00	*	5.60	*	24.30	*	7.08	*	3.88	*
Manganese	mg/kg	7.03	*M*	5.20	*M*	7.14	*M*	8.64	*M*	4.15	*M*	4.08	*M*
Zinc	mg/kg	0.20	*VL*	6.33	*H*	0.33	*L*	1.84	*M*	0.23	*VL*	1.82	*M*
Boron	mg/kg	3.49	*H*	1.91	*M*	1.53	*M*	0.73	*L*	2.09	*H*	0.68	*L*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	18.5	*	22.6	*	18.0	*	11.6	*	21.2	*M*	21.9	*M*
Ex Calcium Percent	%	52.82	*	60.19	*	72.55	*	61.52	*	57.40	*L*	58.37	*L*
Ex Magnesium Percent	%	29.74	*	25.26	*	21.27	*	21.18	*	28.22	*H*	31.06	*H*
Ex Potassium Percent	%	1.76	*	1.52	*	2.48	*	14.94	*	1.68	*Normal*	1.98	*Normal*
Ex Sodium Percent	%	15.56	*H.Sodic*	12.93	*Sodic*	3.58	*N.Sodic*	2.17	*N.Sodic*	12.59	*Sodic*	8.49	*Sodic*
Ex Aluminium Percent	%	0.12	*VL*	0.10	*VL*	0.12	*VL*	0.19	*VL*	0.10	*VL*	0.10	*VL*
Exchangeable Calcium	mg/kg	1957	*H*	2724	*H*	2610	*H*	1423	*H*	2434	*H*	2553	*H*
Exchangeable Magnesium	mg/kg	661	*H*	686	*H*	459	*H*	294	*H*	718	*H*	815	*H*
Exchangeable Potassium	mg/kg	127	*H*	134	*H*	174	*H*	674	*H*	139	*H*	169	*H*
Exchangeable Sodium	mg/kg	663	*FALSE*	673	*FALSE*	148	*FALSE*	57.6	*H.Sodic*	614	*FALSE*	427	*FALSE*
Exchangeable Aluminium	mg/kg	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*	2	*
Exchangeable Calcium	meq/100g	9.79	*M*	13.62	*H*	13.05	*H*	7.12	*M*	12.17	*H*	12.77	*H*
Exchangeable Magnesium	meq/100g	5.51	*H*	5.72	*H*	3.83	*H*	2.45	*M*	5.98	*H*	6.79	*H*
Exchangeable Potassium	meq/100g	0.33	*M*	0.34	*M*	0.45	*M*	1.73	*H*	0.36	*M*	0.43	*M*
Exchangeable Sodium	meq/100g	2.88	*VH*	2.93	*VH*	0.64	*M*	0.25	*L*	2.67	*VH*	1.86	*H*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	1.8	*Low Ca*	2.4	*Low Ca*	3.4	*Low Ca*	2.9	*Low Ca*	2.0	*Low Ca*	1.9	*Low Ca*
Emerson Aggregate	Class	4	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B5: Laboratory analysis data for clay soils. Part 10 of 12.

Table B5. Laboratory Results Clays													
	Lab No	230959-308		230959-312		230959-316		230959-320		230959-324		230959-328	
	Sample ID	59		218		170		219		171		169	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LC		LC		LMC		LC		LC		LMC	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	8.44	*M.Alk*	8.17	*M.Alk*	8.52	*H.Alk*	8.6	*H.Alk*	8.45	*M.Alk*	8.65	*H.Alk*
Electrical Conductivity	dS/m	0.08	*VL.Sal*	0.2	*M.Sal*	0.31	*M.Sal*	0.38	*M.Sal*	0.4	*M.Sal*	0.26	*M.Sal*
Chloride	mg/kg	33.4	*VL.Sal*	78.6	*VL.Sal*	268.0	*L.Sal*	273.0	*L.Sal*	329.0	*M.Sal*	75.2	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	902.0	*L*	1880.0	*M*	1310.0	*L*	1603.0	*M*	2020.0	*M*	1600.0	*M*
Total Phosphorus - Nitric/Perchloric	mg/kg	216.0	*	234.0	*	190.0	*	288.0	*	289.0	*	234.0	*
Phosphorus - Colwell extr	mg/kg	5.46	*L*	10.3	*L*	<5.00	*L*	10.9	*L*	11.9	*L*	<5.00	*L*
Potassium - Colwell ext	mg/kg	222.00	*M*	210.00	*M*	91.00	*VL*	215.00	*M*	392.00	*H*	345.00	*H*
Sulphur - KCl	mg/kg	9.3	*M*	9.8	*M*	18.8	*H*	21.9	*VH*	49.9	*VH*	18.3	*H*
Organic Carbon	%	0.61	*L*	1.93	*H*	1.36	*M*	1.62	*M*	2.6	*H*	1.55	*M*
Copper	mg/kg	0.78	*M*	0.97	*M*	0.96	*M*	1.02	*M*	0.8	*M*	0.92	*M*
Iron	mg/kg	3.92	*	19.30	*	2.82	*	3.02	*	6.54	*	10.80	*
Manganese	mg/kg	10.40	*M*	12.60	*M*	5.46	*M*	4.02	*M*	4.08	*M*	4.48	*M*
Zinc	mg/kg	1.94	*M*	0.74	*L*	1.90	*M*	1.84	*M*	1.82	*M*	1.84	*M*
Boron	mg/kg	0.46	*VL*	0.60	*L*	0.38	*VL*	0.71	*L*	0.76	*L*	1.14	*M*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	7.2	*L*	18.1	*M*	19.2	*M*	26.5	*H*	26.8	*H*	23.5	*M*
Ex Calcium Percent	%	78.15	*Normal*	69.16	*Normal*	66.66	*Normal*	67.96	*Normal*	70.48	*Normal*	66.00	*Normal*
Ex Magnesium Percent	%	11.82	*Normal*	23.47	*H*	24.78	*H*	22.64	*H*	20.67	*H*	25.90	*H*
Ex Potassium Percent	%	6.49	*H*	2.89	*Normal*	1.11	*Normal*	1.93	*Normal*	3.09	*Normal*	2.64	*Normal*
Ex Sodium Percent	%	3.23	*N.Sodic*	4.35	*N.Sodic*	7.34	*Sodic*	7.39	*Sodic*	5.68	*N.Sodic*	5.37	*N.Sodic*
Ex Aluminium Percent	%	0.31	*VL*	0.12	*VL*	0.12	*VL*	0.08	*VL*	0.08	*VL*	0.09	*VL*
Exchangeable Calcium	mg/kg	1124	*H*	2500	*H*	2560	*H*	3607	*H*	3779	*H*	3101	*H*
Exchangeable Magnesium	mg/kg	102	*H*	509	*H*	571	*H*	721	*H*	665	*H*	730	*H*
Exchangeable Potassium	mg/kg	182	*H*	204	*H*	83	*H*	200	*H*	323	*H*	242	*H*
Exchangeable Sodium	mg/kg	53.5	*H.Sodic*	181	*FALSE*	324	*FALSE*	451	*FALSE*	350	*FALSE*	290	*FALSE*
Exchangeable Aluminium	mg/kg	2	*	2	*	2	*	2	*	2	*	2	*
Exchangeable Calcium	meq/100g	5.62	*M*	12.50	*H*	12.80	*H*	18.04	*H*	18.90	*H*	15.51	*H*
Exchangeable Magnesium	meq/100g	0.85	*L*	4.24	*H*	4.76	*H*	6.01	*H*	5.54	*H*	6.08	*H*
Exchangeable Potassium	meq/100g	0.47	*M*	0.52	*M*	0.21	*L*	0.51	*M*	0.83	*H*	0.62	*M*
Exchangeable Sodium	meq/100g	0.23	*L*	0.79	*H*	1.41	*H*	1.96	*H*	1.52	*H*	1.26	*H*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	6.6	*Balanced*	2.9	*Low Ca*	2.7	*Low Ca*	3.0	*Low Ca*	3.4	*Low Ca*	2.5	*Low Ca*
Emerson Aggregate	Class	5	*Slaking*	5	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B5: Laboratory analysis data for clay topsoils. Part 11 of 12.

Table B5. Laboratory Results Clays													
	Lab No	230959-332		230959-336		230959-340		230959-344		230959-348		230959-352	
	Sample ID	58		2		11		12		31		30	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	MC		LMC		HC		MC		LC		LMC	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	8.57	*H.Alk*	8.51	*H.Alk*	8.37	*M.Alk*	8.59	*H.Alk*	7.32	*Neutral*	7.38	*Neutral*
Electrical Conductivity	dS/m	0.19	*M.Sal*	0.18	*L.Sal*	0.2	*M.Sal*	0.12	*L.Sal*	0.27	*M.Sal*	0.41	*M.Sal*
Chloride	mg/kg	70.8	*VL.Sal*	177.0	*L.Sal*	80.6	*VL.Sal*	25.6	*VL.Sal*	311.0	*M.Sal*	481.0	*M.Sal*
Total Nitrogen - Kjeldahl	mg/kg	1970.0	*M*	1910.0	*M*	2090.0	*M*	1680.0	*M*	1260.0	*L*	1780.0	*M*
Total Phosphorus - Nitric/Perchloric	mg/kg	272.0	*	332.0	*	340.0	*	308.0	*	523.0	*	425.0	*
Phosphorus - Colwell extr	mg/kg	13.6	*L*	7.61	*L*	13.6	*L*	35.8	*M*	132	*H*	21.1	*L*
Potassium - Colwell ext	mg/kg	287.00	*M*	232.00	*M*	311.00	*H*	225.00	*M*	293.00	*M*	289.00	*M*
Sulphur - KCl	mg/kg	27.4	*VH*	12.7	*H*	33.8	*VH*	7.5	*L*	29.7	*VH*	9.9	*M*
Organic Carbon	%	2.61	*H*	1.64	*M*	2.19	*H*	1.38	*M*	0.89	*L*	1.49	*M*
Copper	mg/kg	0.8	*M*	0.78	*M*	0.84	*M*	0.8	*M*	0.62	*M*	0.64	*M*
Iron	mg/kg	4.44	*	5.24	*	8.62	*	10.10	*	8.90	*	19.70	*
Manganese	mg/kg	3.92	*M*	7.62	*M*	10.00	*M*	12.20	*M*	12.80	*M*	23.30	*M*
Zinc	mg/kg	1.88	*M*	1.90	*M*	1.90	*M*	1.92	*M*	1.92	*M*	1.94	*M*
Boron	mg/kg	0.76	*L*	1.02	*M*	0.94	*L*	1.02	*M*	0.66	*L*	1.12	*M*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	20.6	*M*	20.4	*M*	18.4	*M*	22.5	*M*	6.8	*L*	13.9	*M*
Ex Calcium Percent	%	72.41	*Normal*	75.64	*Normal*	74.33	*Normal*	73.00	*Normal*	68.87	*Normal*	30.07	*L*
Ex Magnesium Percent	%	21.84	*H*	19.66	*H*	20.53	*H*	22.41	*H*	20.71	*H*	58.39	*H*
Ex Potassium Percent	%	2.93	*Normal*	2.32	*Normal*	3.03	*Normal*	2.15	*Normal*	6.11	*H*	3.41	*Normal*
Ex Sodium Percent	%	2.71	*N.Sodic*	2.28	*N.Sodic*	1.98	*N.Sodic*	2.34	*N.Sodic*	3.98	*N.Sodic*	7.98	*Sodic*
Ex Aluminium Percent	%	0.11	*VL*	0.11	*VL*	0.12	*VL*	0.10	*VL*	0.32	*VL*	0.16	*VL*
Exchangeable Calcium	mg/kg	2978	*H*	3091	*H*	2739	*H*	3279	*H*	942	*H*	836	*H*
Exchangeable Magnesium	mg/kg	539	*H*	482	*H*	454	*H*	604	*H*	170	*H*	974	*H*
Exchangeable Potassium	mg/kg	235	*H*	185	*H*	218	*H*	188	*H*	163	*H*	185	*H*
Exchangeable Sodium	mg/kg	128	*FALSE*	107	*FALSE*	83.9	*H.Sodic*	121	*FALSE*	62.6	*H.Sodic*	255	*FALSE*
Exchangeable Aluminium	mg/kg	2	*	2	*	2	*	2	*	2	*	2	*
Exchangeable Calcium	meq/100g	14.89	*H*	15.46	*H*	13.70	*H*	16.40	*H*	4.71	*L*	4.18	*L*
Exchangeable Magnesium	meq/100g	4.49	*H*	4.02	*H*	3.78	*H*	5.03	*H*	1.42	*M*	8.12	*VH*
Exchangeable Potassium	meq/100g	0.60	*M*	0.47	*M*	0.56	*M*	0.48	*M*	0.42	*M*	0.47	*M*
Exchangeable Sodium	meq/100g	0.56	*M*	0.47	*M*	0.36	*M*	0.53	*M*	0.27	*L*	1.11	*H*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	3.3	*Low Ca*	3.8	*Low Ca*	3.6	*Low Ca*	3.3	*Low Ca*	3.3	*Low Ca*	0.5	*Low Ca*
Emerson Aggregate	Class	4	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*	5	*Slaking*	5	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B5: Laboratory analysis data for clay topsoils. Part 12 of 12.

Table B5. Laboratory Results Clays																		
	Lab No	230959-356		230959-360		**Mean**		**LCL**	**UCL**	**Std Dev**	**Count**	**CI 95%**	**10%ile**		**90%ile**		**Min**	**Max**
	Sample ID	41		41 N				**95%**	**95%**			**(+/-)**						
	Sample Depth	Composite		Composite														
	Field Texture	LC		LMC														
Analyses	**Unit**	-		-														
pH - Water	pH units	7.71	*L.Alk*	8.32	*M.Alk*	*8.5*	*H.Alk*	*8.4*	*8.6*	*0.5*	*68*	*0.1*	*8.0*	*M.Alk*	*9.0*	*H.Alk*	*6.7*	*9.3*
Electrical Conductivity	dS/m	0.13	*L.Sal*	0.28	*M.Sal*	*0.3*	*M.Sal*	*0.28*	*0.37*	*0.2*	*68*	*0.04*	*0.2*	*L.Sal*	*0.5*	*H.Sal*	*0.1*	*1.3*
Chloride	mg/kg	83.2	*VL.Sal*	118.0	*L.Sal*	*261.2*	*L.Sal*	*192*	*330*	*290.1*	*68*	*69*	*60.1*	*VL.Sal*	*463.5*	*M.Sal*	*13.1*	*2019.0*
Total Nitrogen - Kjeldahl	mg/kg	1070.0	*L*	1400.0	*L*	*1289.2*	*L*	*1186*	*1392*	*434.6*	*68*	*103*	*763.8*	*L*	*1928.0*	*M*	*500.0*	*2340.0*
Total Phosphorus - Nitric/Perchloric	mg/kg	290.0	*	336.0	*	*256.4*	*	*233*	*279*	*96.4*	*68*	*23*	*152.8*	*	*345.1*	*	*103.0*	*529.0*
Phosphorus - Colwell extr	mg/kg	10.9	*L*	21.7	*L*	*20.6*	*	*13*	*28*	*25.5*	*49*	*7*	*6.2*	*	*36.3*	*	*5.2*	*132.0*
Potassium - Colwell ext	mg/kg	195.00	*M*	245.00	*M*	*202.1*	*	*157*	*247*	*189.6*	*68*	*45*	*115.9*	*	*270.2*	*	*91.0*	*1660.0*
Sulphur - KCl	mg/kg	19.7	*H*	16.1	*H*	*26.6*	*VH*	*22.36*	*30.83*	*17.8*	*68*	*4.23*	*10.0*	*M*	*46.2*	*VH*	*7.5*	*88.2*
Organic Carbon	%	0.81	*L*	1.43	*M*	*1.4*	*M*	*1.32*	*1.56*	*0.5*	*68*	*0.12*	*0.9*	*L*	*2.1*	*H*	*0.4*	*3.2*
Copper	mg/kg	0.66	*M*	0.72	*M*	*0.8*	*M*	*0.77*	*0.87*	*0.2*	*68*	*0.05*	*0.6*	*M*	*1.1*	*M*	*0.4*	*1.5*
Iron	mg/kg	8.32	*	6.64	*	*10.2*	*	*9*	*11*	*5.4*	*68*	*1*	*3.9*	*	*16.2*	*	*2.8*	*27.4*
Manganese	mg/kg	12.50	*M*	8.32	*M*	*6.9*	*M*	*6.07*	*7.70*	*3.4*	*68*	*0.82*	*4.0*	*M*	*12.2*	*M*	*3.4*	*23.3*
Zinc	mg/kg	1.92	*M*	1.92	*M*	*1.0*	*M*	*0.68*	*1.26*	*1.1*	*53*	*0.29*	*0.2*	*VL*	*1.9*	*M*	*0.2*	*6.3*
Boron	mg/kg	0.56	*L*	0.44	*VL*	*1.5*	*M*	*1.37*	*1.72*	*0.7*	*68*	*0.17*	*0.7*	*L*	*2.6*	*H*	*0.4*	*3.5*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Cation Exchange Capacity	meq/100g	5.2	*VL*	13.1	*M*	*20.0*	*M*	*18.6*	*21.5*	*6.2*	*68*	*1.5*	*13.7*	*M*	*26.9*	*H*	*5.2*	*38.6*
Ex Calcium Percent	%	68.96	*Normal*	65.90	*Normal*	*65.3*	*Normal*	*63.4*	*67.2*	*7.8*	*68*	*1.9*	*57.1*	*L*	*72.7*	*Normal*	*30.1*	*80.3*
Ex Magnesium Percent	%	18.91	*H*	26.08	*H*	*24.8*	*H*	*23.4*	*26.2*	*5.9*	*68*	*1.4*	*20.1*	*H*	*29.8*	*H*	*11.8*	*58.4*
Ex Potassium Percent	%	7.31	*H*	3.32	*Normal*	*2.2*	*Normal*	*1.8*	*2.7*	*2.0*	*68*	*0.5*	*0.9*	*L*	*3.2*	*Normal*	*0.7*	*14.9*
Ex Sodium Percent	%	4.39	*N.Sodic*	4.54	*N.Sodic*	*7.5*	*Sodic*	*6.6*	*8.4*	*3.8*	*68*	*0.9*	*3.3*	*N.Sodic*	*13.6*	*Sodic*	*2.0*	*16.3*
Ex Aluminium Percent	%	0.43	*VL*	0.17	*VL*	*0.1*	*VL*	*0.1*	*0.1*	*0.1*	*68*	*0.0*	*0.1*	*VL*	*0.2*	*VL*	*0.1*	*0.4*
Exchangeable Calcium	mg/kg	711	*H*	1731	*H*	*2633.3*	*H*	*2407.5*	*2859.1*	*950.2*	*68*	*225.8*	*1630.0*	*H*	*3658.6*	*H*	*711.0*	*5560.0*
Exchangeable Magnesium	mg/kg	117	*H*	411	*H*	*593.3*	*H*	*547.3*	*639.2*	*193.2*	*68*	*45.9*	*391.5*	*H*	*879.6*	*H*	*102.0*	*994.0*
Exchangeable Potassium	mg/kg	147	*H*	170	*H*	*150.0*	*H*	*130.8*	*169.1*	*80.5*	*68*	*19.1*	*83.9*	*H*	*204.3*	*H*	*57.7*	*674.0*
Exchangeable Sodium	mg/kg	52	*H.Sodic*	137	*FALSE*	*347.3*	*H.Sodic*	*301.9*	*392.6*	*190.7*	*68*	*45.3*	*116.8*	*H.Sodic*	*637.8*	*H.Sodic*	*52.0*	*766.0*
Exchangeable Aluminium	mg/kg	2	*	2	*	*2.0*	*	*#NUM!*	*#NUM!*	*0.0*	*68*	*#NUM!*	*2.0*	*	*2.0*	*	*2.0*	*2.0*
Exchangeable Calcium	meq/100g	3.56	*L*	8.66	*M*	*13.2*	*H*	*12.0*	*14.3*	*4.8*	*68*	*1.1*	*8.2*	*M*	*18.3*	*H*	*3.6*	*27.8*
Exchangeable Magnesium	meq/100g	0.98	*L*	3.43	*H*	*4.9*	*H*	*4.6*	*5.3*	*1.6*	*68*	*0.4*	*3.3*	*H*	*7.3*	*H*	*0.9*	*8.3*
Exchangeable Potassium	meq/100g	0.38	*M*	0.44	*M*	*0.4*	*M*	*0.3*	*0.4*	*0.2*	*68*	*0.0*	*0.2*	*L*	*0.5*	*M*	*0.1*	*1.7*
Exchangeable Sodium	meq/100g	0.23	*L*	0.60	*M*	*1.5*	*H*	*1.3*	*1.7*	*0.8*	*68*	*0.2*	*0.5*	*M*	*2.8*	*VH*	*0.2*	*3.3*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	*0.0*	*VH*	*0.0*	*0.0*	*0.0*	*68*	*0.0*	*0.0*	*VH*	*0.0*	*VH*	*0.0*	*0.0*
Calcium/Magnesium Ratio	-	3.6	*Low Ca*	2.5	*Low Ca*	*2.8*	*Low Ca*	*2.6*	*3.0*	*0.9*	*68*	*0.2*	*1.9*	*Low Ca*	*3.6*	*Low Ca*	*0.5*	*6.6*
Emerson Aggregate	Class	5	*Slaking*	5	*Slaking*	*4.4*	*	*	*	*	*	*	*	*	*	*	*	*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B6: Laboratory analysis data for gravelly clay topsoils. Part 1 of 3.

Table B6. Laboratory Results Gravelly clays													
	Lab No	230959-52		230959-144		230959-148		230959-156		230959-176		230959-196	
	Sample ID	138a		268a		268b		256		214		228a	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LC		LMC		MC		LMC		MC		MC	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	9.04	*E.Alk*	7.96	*M.Alk*	8.82	*H.Alk*	8.46	*M.Alk*	8.28	*M.Alk*	8.85	*H.Alk*
Electrical Conductivity	dS/m	0.46	*H.Sal*	0.23	*M.Sal*	0.29	*M.Sal*	0.52	*H.Sal*	0.73	*H.Sal*	0.38	*M.Sal*
Chloride	mg/kg	211.0	*L.Sal*	138.0	*L.Sal*	206.0	*L.Sal*	464.0	*M.Sal*	470.0	*M.Sal*	387.0	*M.Sal*
Total Nitrogen - Kjeldahl	mg/kg	783.0	*L*	1270.0	*L*	1320.0	*L*	1290.0	*L*	1340.0	*L*	1290.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	488.0	*	326.0	*	147.0	*	400.0	*	269.0	*	199.0	*
Phosphorus - Colwell extr	mg/kg	6.04	*L*	10.2	*L*	9.8	*L*	9.8	*L*	<5.00	*L*	12.9	*L*
Potassium - Colwell ext	mg/kg	95.30	*VL*	183.00	*M*	135.00	*L*	162.00	*L*	135.00	*L*	126.00	*L*
Sulphur - KCl	mg/kg	122.0	*VH*	10.3	*M*	8.9	*M*	90.7	*VH*	130.0	*VH*	30.5	*VH*
Organic Carbon	%	1.33	*M*	1.14	*M*	1.44	*M*	1.53	*M*	2.22	*H*	1.02	*M*
Copper	mg/kg	1.02	*M*	0.89	*M*	0.83	*M*	1.01	*M*	0.88	*M*	0.76	*M*
Iron	mg/kg	17.40	*	11.00	*	5.92	*	5.90	*	4.84	*	6.96	*
Manganese	mg/kg	5.07	*M*	7.38	*M*	6.24	*M*	4.74	*M*	4.88	*M*	6.24	*M*
Zinc	mg/kg	0.66	*L*	0.46	*L*	0.28	*VL*	0.46	*L*	0.24	*VL*	0.29	*VL*
Boron	mg/kg	2.00	*H*	1.20	*M*	1.76	*M*	1.28	*M*	1.38	*M*	2.11	*H*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	14.0	*	14.1	*	24.1	*	29.1	*	34.7	*	24.7	*
Ex Calcium Percent	%	45.39	*	66.15	*	60.56	*	69.87	*	68.44	*	60.05	*
Ex Magnesium Percent	%	35.48	*	26.39	*	28.21	*	20.23	*	23.18	*	28.38	*
Ex Potassium Percent	%	1.32	*	2.90	*	1.36	*	1.43	*	1.05	*	1.45	*
Ex Sodium Percent	%	17.65	*H.Sodic*	4.39	*	9.78	*Sodic*	8.40	*Sodic*	7.26	*Sodic*	10.03	*Sodic*
Ex Aluminium Percent	%	0.16	*VL*	0.16	*VL*	0.09	*VL*	0.08	*VL*	0.06	*VL*	0.09	*VL*
Exchangeable Calcium	mg/kg	1275	*H*	1859	*H*	2923	*H*	4070	*H*	4748	*H*	2966	*H*
Exchangeable Magnesium	mg/kg	598	*H*	445	*H*	817	*H*	707	*H*	965	*H*	841	*H*
Exchangeable Potassium	mg/kg	72.1	*H*	159	*H*	128	*H*	162	*H*	142	*H*	140	*H*
Exchangeable Sodium	mg/kg	570	*FALSE*	142	*FALSE*	543	*FALSE*	563	*FALSE*	579	*FALSE*	570	*FALSE*
Exchangeable Aluminium	mg/kg	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*VL*	2	*VL*
Exchangeable Calcium	meq/100g	6.38	*M*	9.30	*M*	14.62	*H*	20.35	*VH*	23.74	*VH*	14.83	*H*
Exchangeable Magnesium	meq/100g	4.98	*H*	3.71	*H*	6.81	*H*	5.89	*H*	8.04	*VH*	7.01	*H*
Exchangeable Potassium	meq/100g	0.18	*VL*	0.41	*M*	0.33	*M*	0.42	*M*	0.36	*M*	0.36	*M*
Exchangeable Sodium	meq/100g	2.48	*VH*	0.62	*M*	2.36	*VH*	2.45	*VH*	2.52	*VH*	2.48	*VH*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	1.3	*Low Ca*	2.5	*Low Ca*	2.1	*Low Ca*	3.5	*Low Ca*	3.0	*Low Ca*	2.1	*Low Ca*
Emerson Aggregate	Class	3b	*Slight Disp*	5	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B6: Laboratory analysis data for gravelly clay **top**soils. Part 2 of 3.

Table B6. Laboratory Results Gravelly clays													
	Lab No	230959-200		230959-212		230959-280		230959-292		230959-296		230959-300	
	Sample ID	228b		70		267		221		45		222	
	Sample Depth	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	MC		LMC		LMC		LC		LC		LC	
Analyses	**Unit**	-		-		-		-		-		-	
pH - Water	pH units	8.73	*H.Alk*	8.42	*M.Alk*	8.87	*H.Alk*	8.47	*M.Alk*	8.09	*M.Alk*	8.68	*H.Alk*
Electrical Conductivity	dS/m	0.52	*H.Sal*	0.17	*L.Sal*	0.52	*H.Sal*	0.28	*M.Sal*	0.24	*M.Sal*	0.22	*M.Sal*
Chloride	mg/kg	513.0	*M.Sal*	23.1	*VL.Sal*	675.0	*H.Sal*	72.5	*VL.Sal*	54.4	*VL.Sal*	91.4	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	1190.0	*L*	1150.0	*L*	1090.0	*L*	1480.0	*L*	1380.0	*L*	1430.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	286.0	*	298.0	*	197.0	*	415.0	*	462.0	*	346.0	*
Phosphorus - Colwell extr	mg/kg	9.35	*L*	56.3	*M*	<5.00	*L*	30.9	*M*	29.3	*M*	14.6	*L*
Potassium - Colwell ext	mg/kg	145.00	*L*	160.00	*L*	166.00	*L*	304.00	*H*	169.00	*L*	126.00	*L*
Sulphur - KCl	mg/kg	91.5	*VH*	31.0	*VH*	9.9	*M*	14.7	*H*	20.4	*VH*	17.9	*H*
Organic Carbon	%	1.61	*M*	0.84	*L*	1.41	*M*	1.24	*M*	1.19	*M*	1.38	*M*
Copper	mg/kg	1.01	*M*	1.53	*M*	0.71	*M*	0.86	*M*	0.82	*M*	0.66	*M*
Iron	mg/kg	7.23	*	22.10	*	6.13	*	4.96	*	5.16	*	3.30	*
Manganese	mg/kg	7.23	*M*	10.50	*M*	6.13	*M*	3.90	*M*	6.42	*M*	3.76	*M*
Zinc	mg/kg	0.48	*L*	0.28	*VL*	0.65	*L*	1.84	*M*	1.90	*M*	1.88	*M*
Boron	mg/kg	2.09	*H*	1.75	*M*	2.31	*H*	0.94	*L*	0.76	*L*	3.14	*H*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	17.7	*	13.5	*	22.3	*M*	15.3	*M*	9.1	*L*	11.6	*L*
Ex Calcium Percent	%	57.42	*	68.07	*	53.21	*L*	65.86	*Normal*	71.95	*Normal*	65.47	*Normal*
Ex Magnesium Percent	%	27.93	*	26.26	*	32.30	*H*	25.25	*H*	18.92	*H*	25.67	*H*
Ex Potassium Percent	%	2.01	*	2.36	*	1.75	*Normal*	2.97	*Normal*	4.02	*Normal*	2.54	*Normal*
Ex Sodium Percent	%	12.51	*Sodic*	3.14	*N.Sodic*	12.64	*Sodic*	5.78	*N.Sodic*	4.86	*N.Sodic*	6.13	*Sodic*
Ex Aluminium Percent	%	0.13	*VL*	0.17	*VL*	0.10	*VL*	0.15	*VL*	0.24	*VL*	0.19	*VL*
Exchangeable Calcium	mg/kg	2032	*H*	1832	*H*	2375	*H*	2013	*H*	1312	*H*	1522	*H*
Exchangeable Magnesium	mg/kg	593	*H*	424	*H*	865	*H*	463	*H*	207	*H*	358	*H*
Exchangeable Potassium	mg/kg	139	*H*	124	*H*	152	*H*	177	*H*	143	*H*	115	*H*
Exchangeable Sodium	mg/kg	509	*FALSE*	97.3	*FALSE*	649	*FALSE*	203	*FALSE*	102	*FALSE*	164	*FALSE*
Exchangeable Aluminium	mg/kg	2	*VL*	2	*VL*	2	*	2	*	2	*	2	*
Exchangeable Calcium	meq/100g	10.16	*H*	9.16	*M*	11.88	*H*	10.07	*H*	6.56	*M*	7.61	*M*
Exchangeable Magnesium	meq/100g	4.94	*H*	3.53	*H*	7.21	*H*	3.86	*H*	1.73	*M*	2.98	*M*
Exchangeable Potassium	meq/100g	0.36	*M*	0.32	*M*	0.39	*M*	0.45	*M*	0.37	*M*	0.29	*L*
Exchangeable Sodium	meq/100g	2.21	*VH*	0.42	*M*	2.82	*VH*	0.88	*H*	0.44	*M*	0.71	*H*
Exchangeable Aluminium	meq/100g	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*	0.02	*VH*
Calcium/Magnesium Ratio	-	2.1	*Low Ca*	2.6	*Low Ca*	1.6	*Low Ca*	2.6	*Low Ca*	3.8	*Low Ca*	2.6	*Low Ca*
Emerson Aggregate	Class	4	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*	4	*Slaking*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Table B6: Laboratory analysis data for gravelly clay topsoils. Part 3 of 3.

Table B6. Laboratory Results Gravelly clays																
	Lab No	230959-304		Mean		LCL	UCL	Std Dev	Count	CI 95%	10%ile		90%ile		Min	Max
	Sample ID	259				95%	95%			(+/-)						
	Sample Depth	Composite														
	Field Texture	LMC														
Analyses	Unit	-														
pH - Water	pH units	8.97	H.Alk	8.6	H.Alk	8.4	8.8	0.3	13	0.2	8.1	M.Alk	9.0	H.Alk	8.0	9.0
Electrical Conductivity	dS/m	1.01	VH.Sal	0.4	M.Sal	0.30	0.56	0.2	13	0.13	0.2	M.Sal	0.7	H.Sal	0.2	1.0
Chloride	mg/kg	1190.0	H.Sal	345.8	M.Sal	168	524	327.8	13	178	58.0	VL.Sal	642.6	H.Sal	23.1	1190.0
Total Nitrogen - Kjeldahl	mg/kg	683.0	L	1207.4	L	1079	1336	237.0	13	129	844.4	L	1420.0	L	683.0	1480.0
Total Phosphorus - Nitric/Perchloric	mg/kg	216.0	*	311.5	*	253	370	107.4	13	58	197.4	*	452.6	*	147.0	488.0
Phosphorus - Colwell extr	mg/kg	<5.00	L	18.9	*	9	29	15.6	10	10	9.0	*	33.4	*	6.0	56.3
Potassium - Colwell ext	mg/kg	147.00	L	157.9	*	131	185	49.6	13	27	126.0	*	180.2	*	95.3	304.0
Sulphur - KCl	mg/kg	30.3	VH	46.8	VH	22.48	71.08	44.7	13	24.30	10.0	M	115.9	VH	8.9	130.0
Organic Carbon	%	0.29	EL	1.3	M	1.04	1.52	0.4	13	0.24	0.9	L	1.6	M	0.3	2.2
Copper	mg/kg	0.78	M	0.9	M	0.79	1.02	0.2	13	0.12	0.7	M	1.0	M	0.7	1.5
Iron	mg/kg	2.60	*	8.0	*	5	11	5.7	13	3	3.6	*	16.1	*	2.6	22.1
Manganese	mg/kg	10.40	M	6.4	M	5.22	7.54	2.1	13	1.16	4.1	M	9.8	M	3.8	10.5
Zinc	mg/kg	1.94	M	0.9	M	0.48	1.26	0.7	13	0.39	0.3	VL	1.9	M	0.2	1.9
Boron	mg/kg	1.42	M	1.7	M	1.35	2.05	0.6	13	0.35	1.0	L	2.3	H	0.8	3.1
Cation Extraction Method	Rayment& Lyons	15C1	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Cation Exchange Capacity	meq/100g	16.9	M	19.0	M	14.9	23.1	7.5	13	4.1	12.0	L	28.2	H	9.1	34.7
Ex Calcium Percent	%	40.57	L	61.0	L	55.8	66.2	9.6	13	5.2	47.0	L	69.6	Normal	40.6	72.0
Ex Magnesium Percent	%	35.76	H	27.2	H	24.5	30.0	5.1	13	2.8	20.8	H	34.8	H	18.9	35.8
Ex Potassium Percent	%	2.25	Normal	2.1	Normal	1.6	2.6	0.8	13	0.5	1.3	Normal	3.0	Normal	1.0	4.0
Ex Sodium Percent	%	21.29	H.Sodic	9.5	Sodic	6.6	12.4	5.4	13	2.9	4.5	N.Sodic	16.6	H.Sodic	3.1	21.3
Ex Aluminium Percent	%	0.13	VL	0.1	VL	0.1	0.2	0.1	13	0.0	0.1	VL	0.2	VL	0.1	0.2
Exchangeable Calcium	mg/kg	1369	H	2330.5	H	1742.9	2918.0	1080.8	13	587.5	1323.4	H	3849.2	H	1275.0	4748.0
Exchangeable Magnesium	mg/kg	724	H	615.9	H	492.5	739.4	227.1	13	123.5	371.2	H	860.2	H	207.0	965.0
Exchangeable Potassium	mg/kg	148	H	138.5	H	124.5	152.6	25.9	13	14.1	116.8	H	161.4	H	72.1	177.0
Exchangeable Sodium	mg/kg	826	FALSE	424.4	H.Sodic	290.7	558.1	246.0	13	133.7	110.0	H.Sodic	635.0	H.Sodic	97.3	826.0
Exchangeable Aluminium	mg/kg	2	*	2.0	*	#NUM!	#NUM!	0.0	13	#NUM!	2.0	*	2.0	*	2.0	2.0
Exchangeable Calcium	meq/100g	6.85	M	11.7	H	8.7	14.6	5.4	13	2.9	6.6	M	19.2	H	6.4	23.7
Exchangeable Magnesium	meq/100g	6.03	H	5.1	H	4.1	6.2	1.9	13	1.0	3.1	H	7.2	H	1.7	8.0
Exchangeable Potassium	meq/100g	0.38	M	0.4	M	0.3	0.4	0.1	13	0.0	0.3	L	0.4	M	0.2	0.5
Exchangeable Sodium	meq/100g	3.59	VH	1.8	H	1.3	2.4	1.1	13	0.6	0.5	M	2.8	VH	0.4	3.6
Exchangeable Aluminium	meq/100g	0.02	VH	0.0	VH	0.0	0.0	0.0	13	0.0	0.0	VH	0.0	VH	0.0	0.0
Calcium/Magnesium Ratio	-	1.1	Low Ca	2.4	Low Ca	2.0	2.8	0.8	13	0.4	1.4	Low Ca	3.4	Low Ca	1.1	3.8
Emerson Aggregate	Class	4	Slaking	4.1	*	*	*	*	*	*	*	*	*	*	*	*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic

Whitehaven

Blackwater Mine

Community Consultation Plan

Prepared for the BWM Progressive Rehabilitation and Closure Plan

June 2026

Approval	Name	Position	Signed	Date
Document Owner:	Brendan Dillon	Manager - Approvals		15 June 2026

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1.0 Introduction

This Community Consultation Plan (CCP) has been prepared to support the Progressive Rehabilitation and Closure Plan (PRC Plan) for the Blackwater Mine (BWM), operated by Whitehaven Coal (WHC). The CCP outlines the framework for engaging stakeholders with a genuine interest in rehabilitation and closure planning, in accordance with the requirements of section 126C of the *Environmental Protection Act 1994* (EP Act).

The CCP includes:

- Consultation requirements as part of PRC planning;
- The objectives and desired outcomes for community consultation in PRC planning for BWM;
- 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 Environmental Resources Management Australia Pty Limited (ERM), with consultation support from BWM team members. Its implementation will be led by the BWM Community Relations team, with strategic input from the BWM Closure Planning team.

The CCP is designed to ensure that consultation is inclusive, transparent, and responsive to stakeholder concerns. It reflects WHC's commitment to progressive rehabilitation and responsible mine closure, and aims to align Post-Mining Land Use (PMLU) outcomes with community aspirations and regional development goals.

2.0 PRC Plan Community Consultation Context

2.1 Blackwater Mine Context

BWM is a large-scale open-cut coal operation located in the Bowen Basin, Central Queensland, located approximately 4.5 km southwest of Blackwater, within the Central Highlands Regional Council (CHRC) Local Government Area (LGA). The mine is operated by WHC and includes multiple open-cut pits, waste rock dumps, haul roads, a coal handling and preparation plant, and associated infrastructure. Mining commenced in 1967 and has continued through multiple phases of expansion.

The operation spans 21 mining leases (MLs) and is authorised under Environmental Authority (EA) EPML00717813. In April 2024, Whitehaven Blackwater Pty Ltd, a subsidiary of Whitehaven Coal, acquired the mine from BHP Mitsubishi Alliance (BMA) and is now the holder of the resource authorities.

Mining activities at BMW utilise draglines and supporting pre-strip and coal mining fleets to produce approximately 16 million tonnes per annum of product coal. Operations involve topsoil removal and stockpiling, drilling and blasting of overburden and interburden, and truck-and-shovel mining of both overburden and coal.

The site includes a Coal Handling and Preparation Plant, Thermal Coal Plant, train load-out facilities, Mine Infrastructure Area, and other supporting infrastructure. Currently approved areas are expected to be mined for several decades, with progressive rehabilitation occurring as land becomes available. Final decommissioning and infrastructure removal will occur after mining ceases.

The Gaangalu Nation People have a registered Native Title Claim (QC2012/009) that includes the Blackwater Mine area. Most of the land within the EA boundary is owned by WHC. Other landholders have been detailed in Section 5.

Land ownership maps are provided in Figure 1 and Figure 2.

Ongoing refinement of mining and rehabilitation planning, as reflected in the updated PRC Plan, continues to inform consultation with stakeholders regarding final landform outcomes, PMLUs and Non-use Management Areas (NUMAs).

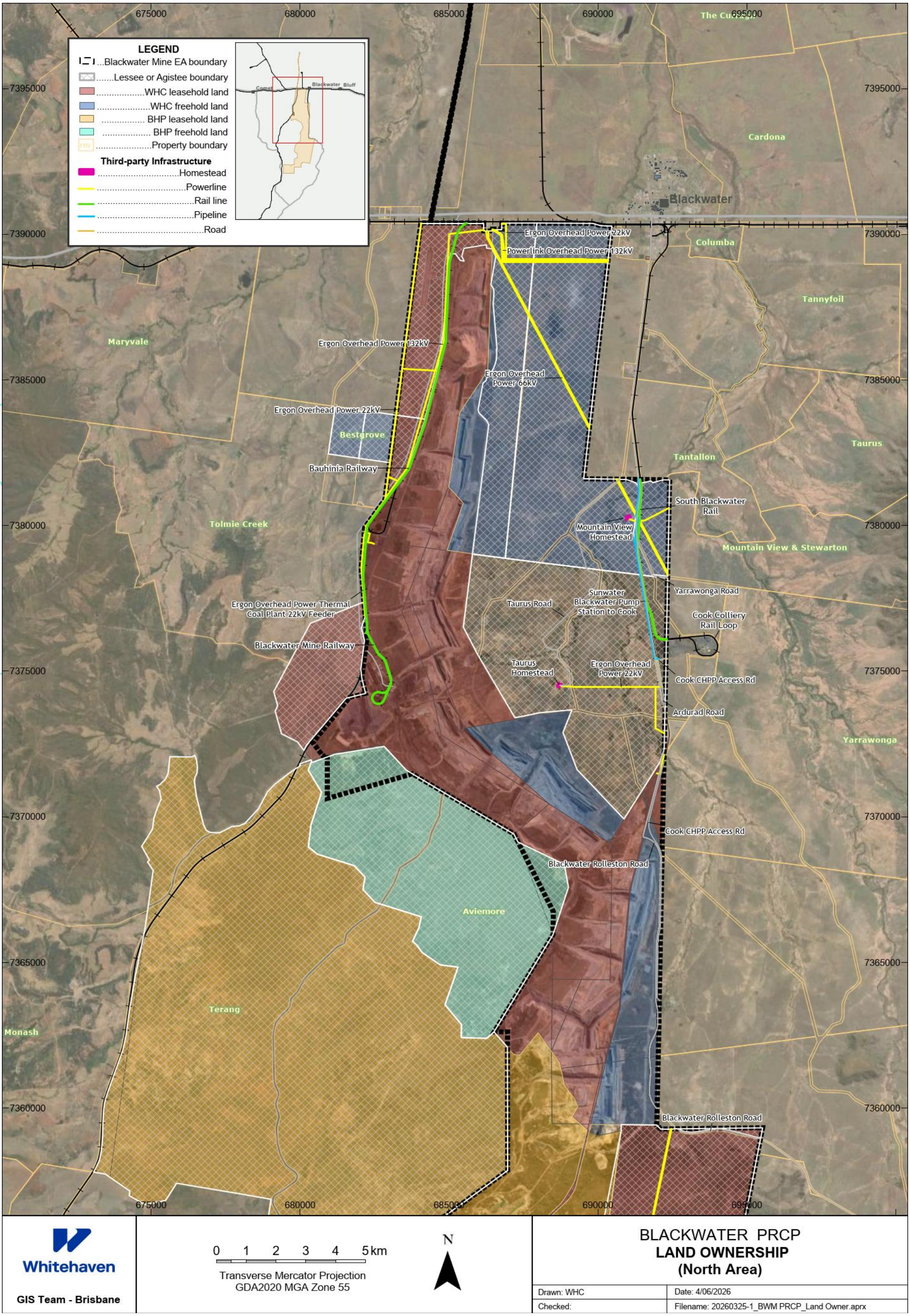


Figure 1 Land Ownership Part 1 (BWM North and Central)

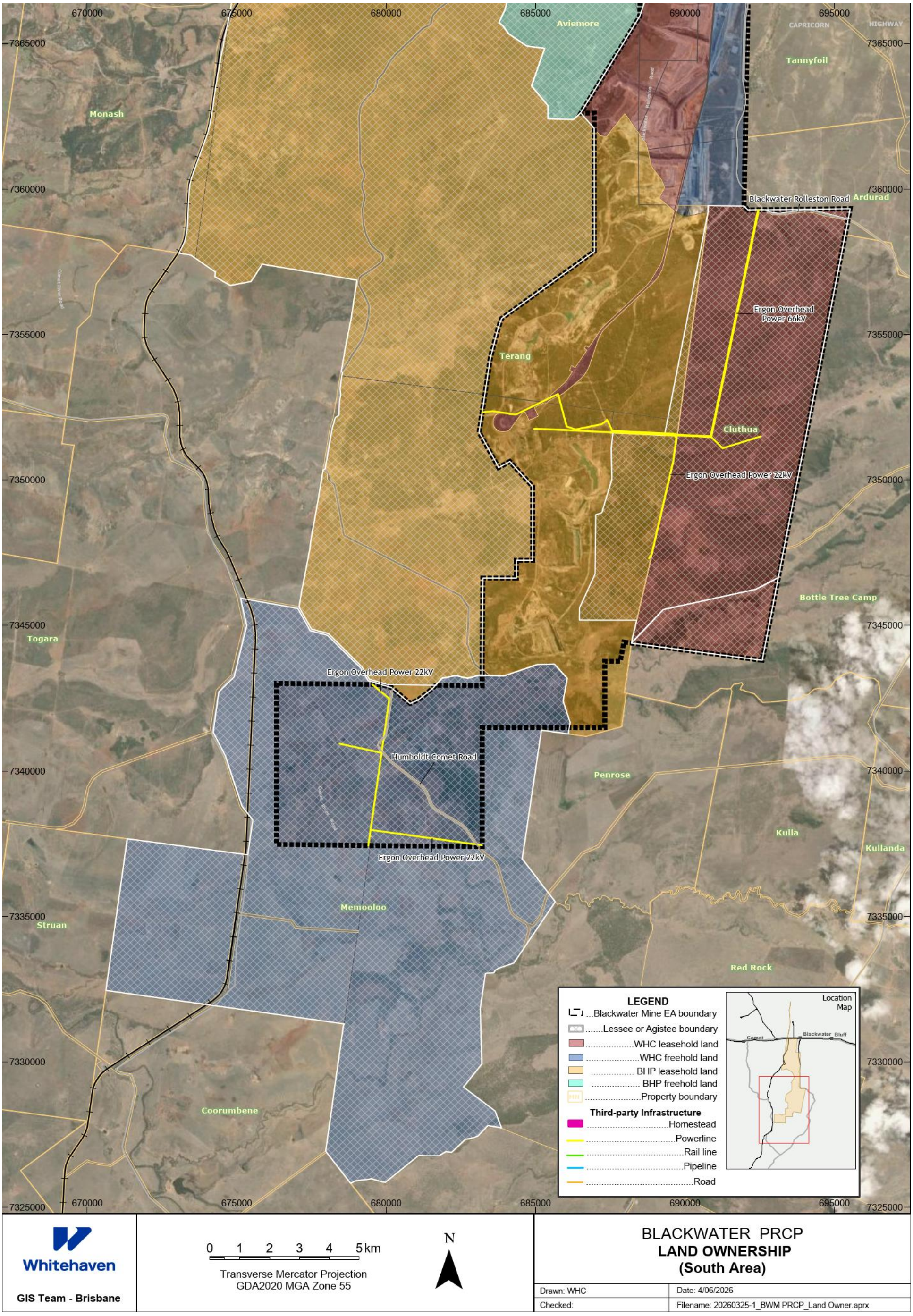


Figure 2 Land Ownership Part 2 (BWM Central and South)

3.0 Regulatory Requirements

3.1 PRC Plan

The BWM PRC Plan and this associated CCP were prepared under the transitional provisions of the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act). Under the MERFP Act, a PRC Plan must be submitted:

- as part of an application for an EA for a new mining activity associated with a mining lease; or
- when submitting an application for a major EA amendment.

Transitional arrangements under the MERFP Act applied to existing operations, including BWM. These arrangements specified a deadline by which a PRC Plan was required to be submitted to the Department of Environment, Tourism, Science and Innovation (DETSI) for assessment and approval. Under these provisions, BMA (former owners of Blackwater Mine) was a 'mining Environmental Authority holder' at the commencement of the MERFP Act and therefore was required a prepare a transitional PRC Plan. A Transition Notice for Blackwater Mine was issued to BMA by the administrating authority on 13 December 2021. The Transitional Notice required submission of the BWM PRCP and PRCP schedule by 15 November 2024.

On 2 April 2024, Whitehaven Blackwater Pty Ltd (Whitehaven) acquired BWM from BMA, and on 29 January 2025 the EA was successfully transferred by the administering authority from BMA to Whitehaven Blackwater Pty Ltd, NS Blackwater Pty Limited and JFE Steel Australia (BW) Pty Ltd.

On 11 November 2024 Whitehaven submitted the Blackwater Mine PRC Plan and PRCP Schedule to DETSI. On 13 June 2025, DETSI issued an *Information Request Notice* to Whitehaven seeking additional information required to complete its assessment of the PRCP application. A response to the information request was due by 19 December 2025.

On 19 December 2025, WHC submitted a Change Application together with an updated PRC Plan and PRCP Schedule to reflect changes to the mine and rehabilitation design approach compared to that proposed by BMA.

Following assessment and ongoing engagement with the administering authority, the PRCP Schedule was approved on 19 May 2026. The PRC Plan has subsequently been updated to align with the approved PRCP Schedule, including refinement of rehabilitation areas, PMLUs and NUMAs, and to reflect changes associated with the Blackwater North Extension Project.

Following approval, the transitional provisions no longer apply, and the approved PRCP Schedule provides the basis for ongoing rehabilitation and closure planning at BWM.A PRC plan consists of two parts:

- a rehabilitation planning part which includes information about the site and its operations, community engagement activities, proposed PMLUs and NUMAs, methodologies and techniques to rehabilitate the land, and it provides timeframes and reasoning for when land becomes available for rehabilitation; and
- a PRC Schedule which includes maps showing final rehabilitation and closure outcomes for the site, and it sets out time-based milestones for achieving PMLUs and/or NUMA outcomes.

The intent of the PRC plan is to specify:

- site rehabilitation commitments, including the amount, type, location, and timing of rehabilitation activities; and
- mining activities, including duration, PMLUs, and how rehabilitation will be carried out.

4.0 Legislative Requirements for Consultation

The EP Act requires site-specific applications for an EA for a mining activity relating to a mining lease to submit a PRC Plan. Existing EA holders were required to submit a PRC Plan under the transitional provisions of the EP Act following commencement of the MERFP Act.

Community consultation must be undertaken when developing and implementing a PRC Plan.

The PRC Plan must include:

- details of the consultation undertaken by the applicant in developing the proposed PRC Plan;
- details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan; and
- the extent to which each proposed PMLU or NUMA is consistent with the outcome of consultation with the community in developing the plan.

The community consultation process for the development of the PRC Plan differs from the public notification process for the EA application or Environmental Impact Statement (EIS).

In accordance with section 126C(1)(c)(iii) and (iv) of the EP Act, the rehabilitation planning part of the PRC Plan must include:

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

To comply with section 126C(1)(d) of the EP Act, the rehabilitation planning part of the PRC plan must state the extent to which each PMLU for land identified in the PRC Plan Schedule for the plan is consistent with:

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

To comply with section 126C(1)(e), (f), (g) and (h) of the EP Act, the PRC Plan must:

- for each proposed PMLU for land, state the applicant's proposed methods or techniques for rehabilitating the land to a stable condition in a way that supports the rehabilitation milestones under the proposed PRC Schedule.
- identify the risks of a stable condition for land mentioned above not being achieved, and how the applicant intends to manage or minimise the risks.
- for each proposed NUMA, state the reasons the applicant considers the area cannot be rehabilitated to a stable condition.
- for each matter mentioned above include copies of reports or other evidence relied on by the applicant for each proposed NUMA.

4.1 Genuine Interest

The Queensland Government's Information Sheet on Community consultation for Progressive Rehabilitation and Closure Plan (ESR/2019/5101) (updated 24 June 2025) further clarifies that it is the responsibility of the applicant to identify, notify and engage the community regarding the rehabilitation and closure of the site and provide them the opportunity to comment.

When selecting members of the community to engage with, applicants must consider who in the broader community is directly influenced by the rehabilitation process or final land outcomes.

To be included in this consultation stage, members of the community must have a genuine interest in:

- the land where the activity will occur
- the land adjacent to where the activity will occur
- the land/amenities surrounding where the activity will occur that are likely to be impacted by the activity (e.g. groundwater/drinking water users within the surrounding area or community located upstream or downstream of the activity).

A genuine interest in the land must be demonstrable and legitimate. It may include, but is not limited to:

- direct impact interest (e.g. underlying and adjacent land holders);
- cultural interest (e.g. Indigenous communities, Traditional Owners including Native Title holders);

- heritage interest (e.g. state or local government or relevant community groups where heritage value is identified on the land the activity is to occur);
- environmental interest (e.g. state or local government or relevant community groups where environmental value is identified on the land the activity is to occur);
- recreational interest (e.g. relevant community groups who use the immediate, adjacent, upstream or downstream land for recreational purposes);
- land use interest (e.g. overlapping tenure holders, agricultural entities or local government where a planning scheme for the land is in place); and or
- health interest (e.g. state or local government or relevant community groups who have health concerns relating to the rehabilitation processes and final land outcomes for the project).

The administering authority must be satisfied that the applicant has attempted to consult with all community members with a genuine interest in the rehabilitation and closure of the project. If the administering authority is not satisfied, it has the ability to request further information from the applicant.

4.2 Community Consultation Plan

To comply with section 126C(1)(c)(iv) of the EP Act, the rehabilitation planning part must include a CCP detailing how ongoing consultation will be carried out in relation to the rehabilitation to be carried out under the PRC Plan.

The CCP must include details of:

- Consultation requirements as part of PRC planning
- The objectives and desired outcomes for community consultation in PRC planning
- 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.

In developing the proposed PRC Plan, the community should at least be engaged on the plan for the mine, PMLUs or NUMAs, areas of disturbance, rehabilitation and management methods, progressive rehabilitation and closure timeframes.

Ongoing community consultation should continue throughout the stages of the mine life so that progressive rehabilitation and the socio-economic and environmental impacts related to mine closure can be discussed with the community.

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

PRC Plans prepared under the former transitional provisions were required to meet the legislative requirements in section 126C(1)(c) of the EP Act.

All proposed PRC Plans must contain a CCP regardless of whether the site has an existing EA.

4.3 Community Consultation Register

To comply with section 126C(1)(c)(iii) of the EP Act, the rehabilitation planning part must include a community consultation register identifying the consultation carried out in developing the PRC Plan. The community consultation register must include:

- Consultation date(s)
- Identification of each community member
- Description of consultation type (workshop, quarterly meetings, etc.)
- Information provided to the community

- Issues raised/discussed by the community
- How issues have been considered
- Decisions/outcomes of engagement
- Commitments made by the applicant.

Consultation should occur prior to any PRC Schedule amendments that are likely to impact the community and the community consultation register should be updated when this consultation is undertaken. The community consultation register serves as a formal record of how stakeholder input has influenced rehabilitation planning and closure outcomes.

The community consultation register for PRC Plans should include all recorded previous engagements with the community. Where there are land outcomes identified in a land outcome document, the applicant must include the details of any previous community consultation undertaken. If previous consultation has not been recorded or is unknown, the applicant must record this in the proposed PRC Plan. Where there are no land outcomes identified in a land outcome document or previous consultation cannot be demonstrated, the applicant is required to comply with the requirements above as if it was a new application. It is recommended that applicants discuss the level of consultation expected in a pre-lodgement meeting prior to developing the PRC Plan.

5.0 Consultation Undertaken for Development of BWM's PRC Plan

5.1 Objectives for Community Consultation

The following objectives guided community consultation undertaken during the development of the BWM PRC Plan and continue to inform ongoing engagement in relation to rehabilitation and closure planning:

1. To engage stakeholders with a genuine interest in developing objectives and aspirations for PMLU and landform, and social value opportunities to be considered in PRC planning.
2. To support transparent access to information about BWM's PRC planning and implementation, enabling opportunities for the Blackwater community, BWM suppliers and government agencies and representatives to provide inputs, and feedback on rehabilitation and closure outcomes.
3. To engage with utility owners and operators, and adjacent mining and energy tenement holders, to provide information about BWM's closure planning that supports them to manage their assets and interests.

5.2 Stakeholder Identification and Analysis

This section identifies the stakeholders with a genuine interest in the rehabilitation and closure of the BWM, in accordance with section 126C(1)(c) of the EP Act.

Stakeholders were identified through the following process and have been engaged during development of the PRC Plan and subsequent updates:

- Review of land tenure and ownership records;
- Analysis of overlapping and adjacent land uses;
- Consultation with Traditional Owner groups and Native Title representatives;
- Engagement with local and state government agencies;
- Review of previous consultation records and community submissions; and
- Internal knowledge from site personnel and community relations teams.

The stakeholders considered to have a genuine interest in BWM's PRC Plan, and who have been consulted during PRC Plan development and updates, include:

- **Traditional Owners:** Gaangalu Nation People as the registered native title applicants and as a party to the Indigenous Land Use Agreement (ILUA)

- **Underlying and Adjacent Landholders:** GH Mackenzie (Taurus and Stewarton Stations), and BMA retains ownership of two properties within the EA area
- **Licensees of Land within BWM EA area:** Includes nine private grazing businesses (TN & FL Richardson and AJ & DI Vipen, BK, DA & GK McKenzie and CD & LE Stewart, Thomas and Christine Maree Boag, Comet Downs Cattle Company Pty Ltd, Trevor & Fenella Neilson, IK & K McCamley, Bruce Robert Black, Jem Family Trust (Jack Mayne), and JM & LA Engwicht), and one registered native title claimant (Gaangalu Nation People)
- **BWM:** General Manager and Mine Personnel
- **Local Government:** CHRC
- **Nearby Landowners (within 5km):** There are 50 private owners of rural properties located within 5 km of BWM's EA area
- **Blackwater Community:** Includes Blackwater residents, business owners, and community organisations and groups
- **Central Highlands Community Groups and Businesses:** Includes Community Groups and Businesses in the Central Highlands Region such as Central Highlands Development Corporation (CHDC)
- **Utilities:** including Sunwater, Department of Transport and Main Roads (DTMR), CHRC, Queensland Rail (QR), Aurizon Network, Ergon Energy Corporation Ltd, Powerlink, Telstra Amplitel, Telstra Vocus, Total Energies
- **Adjacent and Nearby Mining Interests:** Including QCoal Services Pty Ltd (Koorilgah Mine Balloon Railway land) and Coronado Global Resources Inc
- **Petroleum Tenement Holders:** Including Bow CSG Pty. Ltd, Comet Ridge Mahalo North Pty Ltd, Comet Ridge Mahalo Far East Pty Ltd, Comet Ridge Mahalo East Pty Ltd hold, Bronco Energy Pty Limited, and Santos QNT. Pty. Ltd
- **Queensland Government:** DETSI, Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development and Department of Primary Industries (DNRMMRRD), and Department of Primary Industries
- **Queensland Ministerial Representatives:** Queensland Parliament - Member for Gregory
- **Federal Government:** Office of the Minister and Deputy Secretary for Environment Protection, Department of Climate Change, Energy, the Environment and Water (DCCEEW)

Table 1 documents the stakeholders identified as having a genuine interest and outlines the nature of BWM's relationships with each. It also highlights stakeholders' potential areas of interest with respect to BWM's PRC Plan. Further details are provided in the BWM PRC Plan Community Consultation Register.

Table 1 Stakeholders identified as having a Genuine Interest in the BWM PRC Plan

Stakeholder	Existing relationship	Potential areas of interest
Traditional Owners		
Gaangalu Nation People (registered Native Title Claimants)	Former owners, BMA, had regular engagement with Gaangalu Nation People on a range of issues including cultural heritage and community and economic development. This included meetings and correspondence with the Native Title Applicants Group and meetings of the Coordinating Committee, which has been ongoing with respect to ILUA matters since 2002. BMA developed a consultation protocol with Gaangalu Nation People, which was implemented by WHC. BMA developed an ILUA with the Ghungalu People and Kangoulu People (the previous native title applicants) which is dated 31 May 2002. BMA met with the ILUA Coordinating Committee over time as required to address current and future planning issues. The commitments made as part of the ILUA continued to stand after ownership of BWM was transferred to WHC and are assigned to WHC. BMA also engaged with the Gaangalu Nation People Applicants Group to develop a consultation protocol (Ground Rules document) which commits WHC to negotiating a new partnership agreement and a Cultural Heritage Management Plan with the Gaangalu Nation People. WHC continues to engage with Gaangalu Nations People in accordance with the consultation protocol. Ongoing engagement includes discussion of the BWM PRC Plan, including the progressive rehabilitation schedule and NUMA.	• 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

Stakeholder	Existing relationship	Potential areas of interest
Underlying Private Landowners		
One private landowner owns land within the EA area. WHC holds this land as lands lease. BMA retains ownership of two properties within the EA area.	WHC is engaging with the underlying landowner in support of a constructive working relationship. WHC has engaged with the private landowner in relation to the PRC Plan. This included discussion of progressive rehabilitation timeframes and NUMA. WHC and former owners BMA have engaged regarding the land lease agreement, management and use of land within the BWM EA area, an agistment licence held by the landowner for use of BMA-owned land for grazing, and the future use and management of land that BMA has retained within the EA area.	• Environmental management and stewardship • PMLUs, NUMAs and landform/land scape • PRC Plan and PRC 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, property and future business value relating to PMLUs, NUMAs and timing of impacts
Licensees of Land within BWM EA Area		
Nine private grazing businesses and one registered Native Title Claimant as Traditional Owners and cattle grazers.	These private grazing businesses include the following licensees: • TN & FL Richardson and AJ & DI Vipen; • BK, DA & GK McKenzie and CD & LE Stewart; • Thomas and Christine Maree Boag; • Comet Downs Cattle Company Pty Ltd; • Trevor & Fenella Neilson; • IK & K McCamley; • Bruce Robert Black; • Jem Family Trust (Jack Mayne); and • JM & LA Engwicht); The registered Native Title Claimant is the Gaangalu Nation People. The former owners, BMA, engaged with these licensees regarding licence terms and conditions, and matters relating to land use management. WHC has continued to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities and will keep licensees updated on PRC Plan implementation.	• Environmental management/stewardship • PMLU, NUMAs and closure landforms • PRC 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

Stakeholder	Existing relationship	Potential areas of interest
BWM Operations		
General Manager	WHC's Community Relations and Closure Team are in regular consultation with BWM's General Manager.	• Closure timing and planning • Rehabilitation strategy • Workforce transition • Community and economic impact • Local employment and business opportunities in rehabilitation • Legacy and post-closure vision
Mine Personnel	WHC maintains ongoing communication with its personnel on a continual basis through toolbox talks, emails and safety meetings.	• Timing of closure • Rehabilitation obligations • Employment continuity • Management of closure impacts on employment and businesses • Economic and community sustainability • Local employment and business opportunities in rehabilitation
Local Government		
CHRC	CHRC owns land within the EA area and is a party to agreements relating to roads and road reserves. Former owners, BMA, had regular meetings with CHRC as well as meeting with Councillors and officers as-needed on specific issues. BMA provided a preliminary briefing to Council on PRC Plan requirements in 2023. WHC has continued engagement with CHRC. In addition to updates on rehabilitation progress and management of closure impacts on local communities, PRC Plan engagement with CHRC has included specific issues associated with Council-owned land, roads and road reserves within the EA area.	• Local employment • Effects on Council services and infrastructure • Environmental management/stewardship • Rehabilitation progress and PRC 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 relationship	Potential areas of interest
		• Cumulative impacts of closure of multiple mining assets in a similar timeframe (e.g. job and population losses)
Adjacent and Nearby Landholders		
Licenses of land within BWM EA area	WHC has undertaken a process of engagement with licensees regarding licence terms and conditions and will meet with them as and when required. All current licences for WHC-owned land will be transitioned (i.e. continued when their current terms are complete).	• Environmental management/stewardship • PMLU, NUMAs and closure landforms • PRC 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
Private landowners within 5 km of EA area, including owners of properties in Blackwater, and owners of nearby homesteads, grazing and dryland cropping properties, and smaller rural lots.	There are 50 private owners of rural properties located within 5 km of BWM's EA area. Properties include large private landholdings (primarily grazing and dryland cropping) and smaller hobby farms/rural living lots. Nearby landowners include licensees of BMA-owned land. BMA engaged with nearby landowners through letters, emails and letter box drops, on an as-needed basis. WHC is commencing engagement with nearby landowners via letters and meetings, and will continue to engage with landowners via letters, meetings, emails and letter box drops, on an as-needed basis.	• Environmental management/stewardship • PMLU, NUMAs and closure landforms • PRC 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
Blackwater Community		
Blackwater residents, business owners, and community organisations and groups.	BMA conducted a range of engagement activities with community members, from one-off responses to enquiries, to community events and forums, and ongoing engagement processes such as partnerships with community organisations and industry bodies. WHC has engaged with the Blackwater communities via media releases, newspapers advertisements, and social media. WHC has	• Timing of closure • Rehabilitation obligations and progress • Environmental management / stewardship • Employment continuity

Stakeholder	Existing relationship	Potential areas of interest
	committed to engage with Blackwater residents, businesses and community groups to develop a mutually supportive relationship. Engagement activities with community members have and will include community events and forums, and ongoing engagement processes such as partnerships with community organisations and industry bodies. BWM personnel and their families are an important part of the Blackwater community. Engagement with personnel is via toolbox talks and the Blackwater Mine site newsletter.	• Post-mining landforms, and NUMAs • Management of closure impacts on employment and businesses • Economic and community sustainability • Local employment and business opportunities in rehabilitation works
Central Highlands Community Groups and Businesses		
Community Groups and Businesses in the Central Highlands Region	Former owners, BMA, engaged regularly with CHDC over the years, on a broad range of topics. BMA provided a preliminary overview of PRC planning requirements to CHDC in 2023. WHC has engaged with the Central Highlands communities via media releases, newspapers advertisements, and social media. Engagement activities with community members have/will include community events and forums, and ongoing engagement processes such as partnerships with community organisations and industry bodies.	• 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

Stakeholder	Existing relationship	Potential areas of interest

Central Highlands Development Corporation (CHDC)	CHDC is the lead economic and business development agency for the Central Highlands LGA. CHDC's key interests include driving investment, attracting businesses and the sustainability of farms, agribusiness and tourism.
	
	Former owners, BMA, engaged regularly with CHDC over the years, on a broad range of topics. BMA provided a preliminary overview of PRC planning requirements to CHDC in 2023.
	
	WHC has commenced engagement with CHDC, and is seeking to develop a constructive relationship that enables meaningful engagement with CHDC to inform PRC planning over the longer term.
		• As above, with a particular focus on:
		  ○ community and economic sustainability/transition
		  ○ business and economic development opportunities

Utilities		
Utility owners and easement holders with assets within the EA area which include: • Sunwater • DTMR • CHRC • QR • Aurizon Network • Ergon Energy Corporation Ltd • Powerlink • Telstra Vocus • Telstra Amplitel Adjacent land approved for solar farm includes: • Total Energies	WHC is developing working relationships with utility owners and easement holders and will continue issue-specific and transactional engagement with them. • Sunwater is a landowner and easement holder within the EA area and owns and operates the Blackwater Water Pipeline. • DTMR owns and manages the Capricorn Highway and Ardurad (Blackwater -Rolleston) Road. Engagement with DTMR will be on an as-needed basis with respect to road interface and usage arrangements. DNRMMRRD is the administrative authority for a stock route within the EA area. • CHRC owns roads and road reserves that intersect or are directly abutting the BWM EA area, including Yarrawonga Road, Tannyfoil Road, Taura's Road, Ardurad Road, Barlow Road, Humboldt Road and Un-named Roads. • QR owns four railways (Central, South Blackwater Mine, Blackwater Mine and Bauhinia), as well as two loops and two sidings, in the vicinity of the BWM EA area. Aurizon Network operates the rail infrastructure. • Ergon Energy Corporation Ltd owns land within the EA area and holds easements within EA for the purpose of power transmission infrastructure. Powerlink also holds an easement for power supply (22 kV Feeders, 66 kV Transmission Lines, substations and the Rolleston 132 kV Transmission Line). Powerlink also	• Impact on assets/asset value • Remediation of impacts on assets • Any service disruptions and mitigations • Crossing/interface agreements • Timeline for decommissioning utilities • Cost of decommissioning utilities

Stakeholder	Existing relationship	Potential areas of interest
	holds an easement for power supply. • Telstra Amplitel and Telstra Vocus own and operate telecommunications infrastructure, on land owned by State of Queensland. • Total Energies hold a development approval on land that is adjacent to the EA area, for the development and operation of a solar farm. The solar farm is yet to be developed.	
Adjacent and Nearby Mining Interests		
Nearby mining interests: • Curragh Mine to the north of Capricorn Highway (Coronado Curragh Pty Ltd) • Cook's Colliery to the east (QCoal)	WHC liaises with adjoining and nearby mining and resource interests on an as-needed basis. Cook's Colliery has an agreement with WHC to use BWM MLs to access their mine and owns land within the BWM EA area. WHC has a good neighbour agreement with Coronado Curragh Pty Ltd with respect to Curragh Mine, including the accommodation of the East Bedford water pipeline.	• Future land use and ownership • Collaboration on good industry rehabilitation and closure practices • Cumulative impacts and opportunities of mine closures
Petroleum Tenement Holders		
Adjacent and nearby petroleum (gas) tenements: • Bow CSG Pty Ltd • Bronco Energy Pty. Ltd • Santos QNT Pty. Ltd • Comet Ridge Mahalo North Pty Ltd • Comet Ridge Mahalo Far East Pty Ltd • Comet Ridge Mahalo East Pty Ltd	WHC engages with nearby petroleum resource holders in accordance with *Mineral and Energy Resources (Common Provisions) Act 2014* requirements for 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

Stakeholder	Existing relationship	Potential areas of interest
State Government		
Queensland government departments include: • DETSI • DNRMMRRD • Department of Primary Industries • Queensland Parks and Wildlife	Former owners, BMA, provided briefings to the Deputy Director-General Georesources on an as-needed basis, and met and corresponded with (former) Department of Resources regarding resource development commitments. The (former) Department of Resources is the owner of a stock route (416CENT, 348CENT, 413CENT, 353CENT) within the EA area. BMA provided briefings to the Acting Director Native Title Services and Coal Hub on an as-needed basis, and met and corresponded with (former) Department of Resources regarding resource development commitments. The Deputy Director-General Georesources has asked to be kept informed on PRC planning. Amaroo State Forest is in close proximity to BWM, which may be of interest to Department of Primary Industries. Blackwater Conservation Park is located to the near north of BWM, which may be of interest to Queensland Parks and Wildlife and Partnerships.	• 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
Queensland Ministerial Representatives		
• Queensland Parliament - Member for Gregory	WHC provides briefings to the Member for Gregory's Office on an as-needed basis.	• Closure planning • Workforce transition strategies • Community engagement efforts • Economic sustainability initiatives • Opportunities for collaboration
Federal Government		
Office of the Minister and Deputy Secretary for Environment Protection, DCCEEW	WHC provides briefings to the Minister's Office on an as-needed basis.	• Closure planning • Workforce transition strategies • Community engagement efforts • Economic sustainability initiatives • Opportunities for collaboration

6.0 PRC Plan Consultation

6.1 Pre-PRC Plan Development

BWM commenced operations in 1967. An EIS was not required to support provision of an EA for BWM at the time, and there was no requirement for consultation on rehabilitation.

The following rehabilitation and closure-related engagement was undertaken for BWM prior to development of the PRC Plan:

- During 2018, BMA engaged with the former Department of Environment and Science to implement the current EA conditions in relation to post mining land uses and the required acceptance criteria for those PLMUs, which were included in the EA, reflected as Table E1 (Rehabilitation Requirements);
- During 2020 to 2022, ongoing engagement with the former Department of Environment, Science, and Innovation in relation to the application of PRC Guideline elements (including transitional arrangements at the time) and the current EA conditions related to rehabilitation and closure would transition to BMA's PRC Plans;
- During 2023, high level information about the BWM PRC Plan process was provided by BMA to CHRC and CDHC; and
- On an ongoing basis, BMA engaged with nearby landholders on land management and lease/license conditions, and on operational, environmental management and/or water matters, as required, with aspects of this engagement informing the development of the PRC Plan.

Agreements which are in place with respect to BWM include:

- Various Compensation Agreements in place for surface rights, public road access, a homestead, as well as an agistment licences for grazing
- Various crossing/interface access agreements with third-party utility owners and easement holders
- An agreement with Cook Colliery to use BWM MLs to access their mine
- A Compensation Agreement with underlying landowners GH Mackenzie (Taurus and Stewarton Stations) relating to a land lease agreement, management and use of land within the BWM EA area (on ML1759 and ML1762), and an agistment licence held by the landowner for use of BMA-owned land for grazing.

This early engagement provided context for subsequent consultation undertaken during preparation of the PRC Plan and informed the development of proposed rehabilitation strategies, PMLUs and NUMAs presented in the PRC Plan.

6.2 Part of PRC Plan Development

BMA Consultation

Community consultation as part of initial PRC Plan development was undertaken by former owners BMA between February and March 2024. This consultation informed early development of the PRC Plan, which has subsequently been refined and updated through the PRCP Schedule assessment process.

Consultation included letters sent via post, email and a letter drop to all premises in the Blackwater postal area, with stakeholders including:

- Gaangalu Nation People as the registered native title applicants and as a party to the ILUA;
- The owners of underlying freehold land within the BWM EA area;
- Licensees of Land within BWM EA area;
- BWM General Manager and mine personnel;
- CHRC;
- Landowners whose properties are within 5 km of the BWM EA area, including private landowners and licensees of WHC land;

- The Blackwater community;
- Central Highlands Community Groups and Businesses;
- Owners of utility assets within and adjacent to BWM (Sunwater, DTMR, CHRC, QR, Aurizon Network, Ergon Energy Corporation Ltd, Powerlink, Telstra Amplitel, and Telstra Vocus);
- The owner of an adjacent approved but not yet built solar farm (Total Energies);
- Owners of adjacent and nearby mining interests;
- Adjacent petroleum tenement holders;
- Queensland Government: DETSI, DNRMMRRD, and the Department of Primary Industries;
- Queensland Member for Gregory; and
- Office of the Minister and Deputy Secretary for Environment Protection, DCCEEW.

The following information was provided in letters issued by BMA to stakeholders:

- BWM's location and approved activities;
- Queensland Government requirements for mine rehabilitation and closure planning;
- The scope and purpose of the PRC Plan;
- BMA's commitment to progressive rehabilitation;
- Rehabilitation objective for BWM;
- EP Act requirements for rehabilitation;
- PRC Plan requirements;
- Progressive rehabilitation, with disturbed areas rehabilitated as soon as practical;
- Approved post mining land use options;
- Inclusion of residual voids as NUMA;
- Timeframe for BMA's divestment of BWM;
- Transfer of mine operations and rehabilitation to BWM's new owner (i.e. WHC); and
- Responsibility for future engagement on PRC Plan.

The letter included an invitation to engage in further discussions about the PRC Plan. There were no enquiries or feedback received from stakeholders in response to the letter, with the exception of the Gaangalu Nation People who sought additional detail in relation to the timing of BWM's closure, the reasons for PRC planning, the timing of BWM's divestment to WHC, and the progress on the consultation protocol, with this feedback informing subsequent engagement and refinement of PRC planning.

In addition to the letter box drop to Blackwater residents, businesses and community groups, information regarding the PRC Plans progressive rehabilitation, requirements and purpose, timing for plan development, contact details and ongoing engagement commitments was distributed to BWM's workforce, Blackwater community members and BWM suppliers via:

- Coal Connect (an online weekly newsletter to all internal coal personnel);
- Community Connect (a bi-monthly newsletter distributed to more than 15,000 community members throughout the Bowen Basin); and
- BWM's site newsletter.

There were no enquiries or feedback in response to communication via Coal Connect, Community Connect and the BWM site newsletter.

BMA also met with the Gaangalu Nation People Applicants Group on 14 March 2024 to discuss the PRC Plan, among other issues related to BWM. Aspects discussed included the timing for BWM's closure, the reasons for doing PRC planning, the timing for BWM's divestment to WHC, and the progress of consultation protocol. Information was provided to Gaangalu Nation People about PRC Plan requirements, BWM's closure timeframe, the timing for divestment, and progress with the

consultation protocol. The methods and outcomes of engagement are shown in the Community Consultation Register submitted as part of the PRC Plan.

Following acquisition of BWM, Whitehaven undertook further consultation to support refinement of the PRC Plan and PRCP Schedule, including incorporation of updated mine planning and rehabilitation design.

Further engagement occurred during subsequent revisions to the PRC Plan and PRCP Schedule, including in response to the administering authority Information Request and Change Application processes, with consultation focusing on refinement of rehabilitation strategies, PMLUs and NUMAs.

WHC Consultation

Consultation undertaken by WHC in July-September 2025 included in-person meetings, letters, newsletter articles, emails, and phone calls to stakeholders in support of refining the PRC Plan and PRCP Schedule for assessment by the administering authority:

- Gaangalu Nation People;
- BWM: General Manager and mine personnel;
- CHRC;
- Landowners whose properties are within 5 km of the BWM EA area, including private landowners and licensees of BMA land;
- The Blackwater community;
- Central Highlands Community Groups and Businesses;
- Queensland and Federal Ministerial Representatives - Member for Gregory (State Government) and Member for Flynn (Federal Government)

The following information was provided to stakeholders:

- BWM location, approved activities and production;
- Requirements and timing for PRC Plan development, including information requirements;
- The plan for the mine (proposed site design);
- PMLUs and NUMAs, and the progressive rehabilitation schedule;
- Overview of consultation conducted to-date for the PRC Plan, and the requirement for consultation to inform the PRC Plan;
- Commitment to future engagement and participation in the process; and
- Contact details for the relevant WHC team (e.g. for landholders, the Land Management team) for further information, discussion or feedback.

The results of engagement are shown in the BWM Community Consultation Register submitted as part of the PRC Plan, as outlined in Appendix 1 and have informed refinement of PMLUs and NUMAs reflected in the approved PRCP Schedule and updated PRC Plan.

Consultation undertaken by both BMA and Whitehaven informed the development and subsequent refinement of the PRC Plan and PRCP Schedule. These inputs have been considered in establishing the final rehabilitation framework, including PMLUs, NUMAs and closure strategies, which are now reflected in the approved PRCP Schedule and supporting PRC Plan.

7.0 Future, Ongoing PRC Plan-Related Community Consultation

Following approval of the PRCP Schedule and ongoing implementation of the PRC Plan, consultation will be undertaken in accordance with the program documented in Table 2, which includes:

- Consultation objectives;

- Stakeholders addressed by each objective;
- Engagement type; and
- Proposed frequency of consultation.

WHC will monitor progress against these objectives as part of its regular reviews of consultation commitments and outcomes and ongoing implementation of the PRC Plan.

Section 8 describes the information to be released to the community, and Section 9 describes how feedback or comments will be considered.

Table 2 Consultation Program for PRC Plan Implementation

Consultation Objective #1:	*To engage stakeholders with a genuine interest in developing objectives and aspirations for PMLU and landform, and social value opportunities to be considered in PRC planning*	
Stakeholders	**Engagement Type**	**Proposed Consultation Frequency**
Gaangalu Nation People	Meet with the Gaangalu Nation People to provide an update on the PRC Plan and progress with rehabilitation, and invite inputs and feedback on: • 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; • Access to land within the EA area as provided in the ILUA and as agreed with the Coordinating Committee; • Rehabilitation methods, schedule and progress towards milestones • Involvement of businesses owned by Gaangalu Nation People in rehabilitation works • The pipeline of opportunities relating to rehabilitation work and land management • The need for an Indigenous business capability development program to match rehabilitation opportunities, if this is required	As requested, or as agreed with representatives
Underlying Landowners	Advise the landowner in writing when the PRC Plan is approved, including how to access the PRC Plan.	Once-off
	Meet with the landowner to discuss any proposed changes to the PRC Plan (as and when amended) that affect the landowners' interests in freehold land within the EA, and/or other areas within the EA area that are of interest to the landowner, such as: • PMLUs, NUMAs and post-mining landforms, including any particular values or opportunities in specific disturbed areas; • Land that may be available for grazing or other purposes after rehabilitation; • Access to water resources; • 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); and/or • Rehabilitation methods, schedule and progress towards milestones.	As required to address PRC Plan consultation requirements for amendment of the BWM PRC Plan

Consultation Objective #1:	*To engage stakeholders with a genuine interest in developing objectives and aspirations for PMLU and landform, and social value opportunities to be considered in PRC planning*	
Stakeholders	**Engagement Type**	**Proposed Consultation Frequency**
	Correspond and meet with the landowner commencing five years prior to the forecast cessation of mining and as agreed with the landowner, to discuss: rehabilitation objectives and timeframes, PMLUs and NUMAs, land access and tenure arrangements, and other land use/management/rehabilitation issues as relevant to the private freehold land.	Five years prior to the forecast cessation of mining, and as agreed during pre-closure period
	Correspond with the landowner to initiate the legal/statutory and consultation processes required to enable relinquishment of rights and interest in the freehold land within the EA area.	One year prior to the forecast cessation of mining
Licensees of Land within BWM EA area Nearby Landowners (within 5 km)	Advise adjacent and nearby landholders, including licensees, in writing when the PRC Plan is approved, including how to access the PRC Plan.	Once-off
	Advise in writing, and meet if requested, regarding any proposed changes to the BWM PRC Plan (as and when amended) that have potential to affect landowners or licensees' interests in freehold land within or adjacent to the EA area.	As required to address PRC Plan consultation requirements for amendment of the BWM PRC Plan
	Communicate with licensees of land that is within or adjacent to the EA area during the terms of their licence and seek their inputs the PRC Plan schedule, PMLUs and NUMAs during PRC Plan revisions and amendments.	As required to address PRC Plan consultation requirements for amendment of the BWM PRC Plan
	Correspond and if requested meet with adjacent landholders to the EA area (landowners and licensees of land owned by BWM's owner) during the pre-closure, closure/decommissioning and rehabilitation periods, to reduce the potential for works to impact on their amenity, land use, property access or access to water.	Five years prior to the forecast cessation of mining, at least annually, or as agreed with the landowner

Consultation Objective #2:	*To support transparent access to information about BWM's PRC planning and implementation, enabling opportunities for the Blackwater community, BWM suppliers and government agencies and representatives to provide inputs and feedback on rehabilitation and closure outcomes*	
Stakeholders	**Engagement Type**	**Proposed Consultation Frequency**
BWM: General Manager and Mine Personnel	Keep the BWM workforce updated if there are changes to the PRC Plan.	Ongoing engagement process
Blackwater Community	Using community forums such as interagency meetings, partnership meetings and community and business networks, provide community updates on PRC planning (BWM-specific as relevant, and portfolio wide).	Ongoing engagement process
Blackwater Businesses	Provide information about the pending closure of BWM and potential future supply opportunities as part of closure and rehabilitation to local businesses, Traditional Owner businesses and WHC suppliers.	Five years prior to decommissioning; subsequent consultation to be agreed
Local Government State Government Queensland Ministerial Representatives	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 Gregory (Queensland Parliament) • PRC Plan Team and Regional Director Queensland Parks and Wildlife Service and Partnerships - Mackay (DETSI) • Deputy Director-General, Fisheries and Forestry (Department of Primary Industries) • Director, Native Title Services and Coal Hub (DNRMMRRD) • Deputy Director-General of Georesources (DNRMMRRD) • Executive Director, Minerals and Coal (DNRMMRRD) • Assistant Secretary Assessments and Governance Branch, DCCEEW	As requested, or as agreed with representatives

Consultation Objective #3:	*To engage with utility owners and operators, and adjacent mining and energy tenement holders, to provide information about BWM's closure planning that supports them to manage their assets and interests*	
Stakeholders	**Engagement type**	**Proposed consultation frequency**
BWM: General Manager and Mine Personnel	Involve internal WHC stakeholders in PRC Plan processes to build capacity for community consultation on PRC Plan issues and support effective delivery of PRC Plans.	Ongoing
Utility Owners: Sunwater, DTMR, CHRC, QR, Aurizon Network, Ergon Energy Corporation Ltd, Powerlink, Telstra Amplitel, Telstra Vocus, Total Energies	Engage with relevant utility owners to inform them of closure timelines and rehabilitation activities relevant to the land.	Initiated three years prior to decommissioning
	Maintain correspondence regarding progressive rehabilitation and undertake consultation regarding interface agreements, as required if rehabilitation will affect utilities.	During the three years prior to decommissioning
Adjacent and Nearby Mining Interests: Including QCoal Services Pty Ltd (Koorilgah Mine Balloon Railway land) and Coronado Global Resources Inc Petroleum Tenement Holders: Including Bow CSG Pty. Ltd, Comet Ridge Mahalo North Pty Ltd, Comet Ridge Mahalo Far East Pty Ltd, Comet Ridge Mahalo East Pty Ltd hold, Bronco Energy Pty Limited, and Santos QNT. Pty. Ltd	Write to advise adjacent and nearby resource interests if there are any substantive changes to the closure and rehabilitation schedule in the PRC Plan. At a business level, WHC will participate in industry and research partnerships of relevance to PRC Plan and rehabilitation.	As requested, or as agreed with representatives/mining operations
State Government	Provide updates on PRC Plan to the Director Native Title Services and the Deputy Director General (DNRMMRRD) in writing or through regular meetings.	As requested, or as agreed with DNRMMRRD representatives

8.0 Information to be Released for Community Consultation

Whilst many stakeholders in the Central Highlands 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 BWM PRC planning and implementation will include:

- The rationale and scope for PRC planning;
- The approved activities, PMLUs and NUMAs for BWM;
- On-site activities and areas of disturbance;
- Proposed rehabilitation methods, schedule and milestones;
- Updates to the PRC Plan and PRCP Schedule, including changes to rehabilitation areas, PMLUs and NUMAs arising from ongoing mine planning and consultation;
- Alignment with long-term transformation planning occurring through CHRC, 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 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 WHC assets.

9.0 How Feedback/Comments will be Considered

As noted in the DETSI PRC Plan Guidelines, in addition to the annual return requirements that relate to EAs, if a PRC Schedule applies to the activities, then the annual return must also include an evaluation of the effectiveness of the PRC Schedule, including the environmental management carried out under the schedule, for the year to which the annual return relates.

WHC 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, PRC Schedule progress will be reported as part of annual return submissions to DETSI.

Information about rehabilitation progress will also be delivered as part of the consultation methods detailed in Table 2, and feedback will be documented in BWM PRC Plan updates or amendments.

The PRC Plan Community Consultation Register will also be updated as community consultation activities outlined in Table 2 are completed. All stakeholder feedback recorded in the Community Consultation Register will be considered in framing and detailing future PRC Plan amendments for BWM.

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 PRC Plan (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.

WHC has sought CHRC's views on consultation options to involve Council in future PRC Plan consultation for WHC assets. WHC will utilise Council's preferred options to seek inputs on, for example, community aspirations for PMLU and social value opportunities.

10.0 PRC Plan CCP Review

Review of the BWM 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.

11.0 BWM PRC Plan Community Consultation Register

Details of community members and previous engagement, PRC Plan development engagement and engagement outcomes are included in the BWM PRC Plan Community Consultation Register in Appendix 1.

12.0 Definitions

Term	Definition
BMA	BHP Billiton Mitsubishi Alliance
BWM	Blackwater Mine
CCP	Community Consultation Plan
CHRC	Central Highlands Regional Council
CHDC	Central Highlands Development Corporation
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DETSI	Department of Environment, Tourism, Science and Innovation (Queensland, formerly the Department of Environment and Science / the Department of Environment, Science and Innovation) *DETSI is the Queensland Authority responsible for assessing and approving PRC Plans and schedules.*
DNRMMRRD	Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development (Queensland, formerly the Department of Resources)
DTMR	Department of Transport and Main Roads (Queensland)
EA	Environmental Authority
EIS	Environmental Impact Statement – primary approval document for major projects under the *State Development and Public Organisations Act 1971* and EP Act
EP Act	*Environmental Protection Act 1994* (Queensland)
ERM	Environmental Resources Management Australia Pty Limited

Term	Definition
ILUA	Indigenous Land Use Agreement
LGA	Local Government Area
MERFP Act	*Mineral and Energy Resources (Financial Provisioning) Act 2018* (Queensland)
ML	Mining Lease
NUMA	Non-Use Management Area – *'means an area of land the subject of a PRC plan that can not be rehabilitated to a stable condition after all relevant activities for the PRC plan carried out on the land have ended'* (EP Act, Section 112)
PMLU	Post-Mining Land Use – *'for land the subject of a PRC plan, 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'* (EP Act, Section 112)
PRC Plan	Progressive Rehabilitation and Closure Plan
QR	Queensland Rail
WHC	Whitehaven Coal

APPENDIX 1 BWM PRC Plan Community Consultation Register

Blackwater Mine PRCP - Community Consultation Register

KEY STAKEHOLDERS WITH GENUINE INTEREST AND PREVIOUS ENGAGEMENT					COMMUNITY CONSULTATION REGISTER						
Priority	**Stakeholder Group**	**Stakeholder Title**	**Organisation**	**Previous Engagement / Stakeholder Context**	**Actual Consultation Date / Place**	**Consultation Type / Meeting Attendance (e.g. Community Member / Government rep., etc)**	**Information Provided**	**Issues Raised / Discussed (e.g. PMLU / NUMA)**	**How Issues were Considered**	**Decisions / Outcomes of Engagement (e.g. PLMU / NUMA Commitments)**	**Commitments (including Revised Design)**
1	**Traditional Owners**	Gaangalu Nation People (Registered Native Title Claimants)	Gaangalu Nation People Applicants Group	BMA had regular engagement with Gaangalu Nation People on a range of issues including cultural heritage and community and economic development. This included meetings and correspondence with the Native Title Applicants Group and meetings of the Coordinating Committee, which has been ongoing with respect to ILUA matters since 2002. BMA developed a consultation protocol with Gaangalu Nation People, which will be implemented by Whitehaven Blackwater Pty. Ltd. BMA developed an ILUA with the Ghungalu People and Kangoulu People (the previous native title applicants) which is dated 31 May 2002. BMA met with the ILUA Coordinating Committee over time as required to address current and future planning issues. The commitments made as part of the ILUA continued to stand after ownership of BWM was transferred to Whitehaven Blackwater and are assigned to Whitehaven Blackwater. BMA also engaged with the Gaangalu Nation People Applicants Group to develop a consultation protocol (Ground Rules document) which commits Whitehaven Blackwater to negotiating a new partnership agreement and a Cultural Heritage Management Plan with the Gaangalu Nation People. Whitehaven Blackwater has commenced engagement with Gaangalu Nations People in accordance with the consultation protocol. Ongoing engagement will include discussion of the BWM PRC plans, including the progressive rehabilitation schedule and non-use management areas.	15 September 2025	Ghangalu Nation Applicants (Traditional Owners).	Information emailed. Information to presented in meeting in person, information included information on Rev 2 and Rev 3 PRCP's. Follow up meeting proposed	NUMA issues/feedback on the use of these voids after mining eg water quality, grazing and woodlands. Access to land after mining for cultural purposes	Consideration for different types of land forms and reduction of NUMA size. Also the development of new technology until closure that would create more opportunities	Plan additional discussions/meeting to keep GNP informed	Next meeting date to be advised
					16 February 2024 14 March 2024	Letter, via email to Applicants Group	PRC plan requirements and timing for BWM Commitment to progressive rehabilitation PRC purpose and scope EPA's rehabilitation requirements Post mining land use options Inclusion of residual voids to be transitioned as non-use management areas New owner's responsibility for PRC plan and consultation Invitation to discuss the PRC plan	Timing for BWM's closure, and reasons for doing PRC planning now. Timing for BWM's divestment to Whitehaven Coal. Progress of consultation protocol.	BMA provided information to Gaangalu Nation People about PRC plan requirements, BWM's closure timeframe, the timing for divestment, and progress with the consultation protocol.	Whitehaven Blackwater Pty. Ltd. will engage with Gaangalu Nation People according to the consultation protocol developed with them during 2023-2024. It is expected that Traditional Owners' interest in environmental management and mine rehabilitation will be progressed as part of ongoing engagement with them. Traditional Owners will continue to have access to land within the EA area in accordance with the terms of the registered Indigenous Land Use Agreement.	Whitehaven Blackwater Pty. Ltd. will continue to consult with the Gaangalu Nation People, and seek their inputs on rehabilitation and PMLUs as part of PRC plan implementation and any future iterations of the PRC plan. Whitehaven Blackwater Pty. Ltd. 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, and seek to involve Traditional Owners' businesses in supplying progressive rehabilitation works.
					22 July 2024	Meeting to engage with the Gaangalu Nation People on WHC's future approval plans and to provide an overview on the BWM PRCP.	Information was provided on WHC's future approval plans and in regards to post-mining land uses and non-use management areas as associated with the BWM PRCP.	The Gaangalu Nation People had several questions regarding the timing of the post-mining land uses and potential opportunities for their people to be involved in future rehabilitation work.	Whitehaven Blackwater provided information to the Gaangalu Nation People in relation to the whole PRCP process and details covered by the PRCP.	Whitehaven Blackwater will continue to engage with the Gaangalu Nation People through the PRCP process with a particular focus on PMLU's and future rehabilitation work..	Whitehaven Blackwater will continue to engage with the Gaangalu Nation People through the PRCP process with a particular focus on PMLU's and future rehabilitation work..
2	**Underlying Landowners**	Underlying landowner, also a licensee of Whitehaven Blackwater-owned land - GH Mackenzie (Taurus and Stewarton Stations)	Private grazing business	Whitehaven Blackwater has engaged with the owner of the of land which underlies ML1759 and ML1762, regarding a land lease agreement, management and use of land within the BWM EA area.	February 2026	Meeting to discuss the Blackwater North Extension Project and associated Rev 3 PRCP.	Information to presented in meeting in person, information included information on Rev 2 and Rev 3 PRCP's and also Blackwater North Extension Project.	No enquiries or feedback received. Areas of interest as indicated in previous engagement include use of land within the EA area under a licence agreement, and future use of disturbed land for grazing.	The landowner's interest in use of the land for grazing was considered in framing PMLUs.	No new outcomes other than those previously discussed (see below).	Whitehaven Blackwater Pty. Ltd. will continue to engage with the underlying landowner and seek their inputs on BWM's rehabilitation schedule.
		Underlying landowner, also a licensee of Whitehaven Blackwater-owned land - GH Mackenzie (Taurus and Stewarton Stations)	Private grazing business	BMA has had a long and constructive working relationship with the owner of land which underlies ML1759 and ML1762, regarding a land lease agreement, management and use of land within the BWM EA area, and an agistment licence held by the landowner for use of BMA-owned land for grazing.	16 February 2024	Letter, via post	BWM location and approved activities Queensland Government requirements for mine rehabilitation and closure planning Scope and purpose of PRC plan Commitment to progressive rehabilitation Rehabilitation objective for BWM EP Act requirements for rehabilitation PRC plan requirements Progressive rehabilitation with disturbed areas rehabilitated as soon as practical Approved post mining land use options Inclusion of voids as non-use management areas Timeframe for BMA's divestment of BWM Transfer of mine operations and rehabilitation to new Owner Responsibility for future engagement on PRC plan Invitation to seek information or discussion	No enquiries or feedback received. Areas of interest as indicated in previous engagement include use of land within the EA area under a licence agreement, and future use of disturbed land for grazing.	The landowner's 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 the licence agreement with the landowner. Landholders and cattle will be excluded from affected areas while 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).	Whitehaven Blackwater Pty. Ltd. will continue to engage with the underlying landowner and seek their inputs on BWM's rehabilitation schedule and approved PMLUs as part of PRC plan implementation and any future amendments of the PRC plan.
		Manager, Land Approvals and Tenements	BMA	BMA retains ownership of two properties within the EA area. Whitehaven Blackwater and BMA have engaged regarding the future use and management of land that BMA has retained within the EA area.	January 2025-January 2026	Various meetings	Management and future use of WHC-owned land within the BWM EA area	Management and future use of WHC-owned land within the BWM EA area	WHC's intentions for WHC-owned land within the BWM EA area have been considered in the PRC plan.	As below.	As below.
		Manager, Land Approvals and Tenements	BMA	BMA retains ownership of two properties within the EA area. Whitehaven Blackwater and BMA have engaged regarding the future use and management of land that BMA has retained within the EA area.	January-April 2024	Various meetings and correspondence	Management and future use of BMA-owned land within the BWM EA area	Management and future use of BMA-owned land within the BWM EA area	BMA's intentions for BMA-owned land within the BWM EA area have been considered in the PRC plan.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	Whitehaven Blackwater Pty. Ltd will engage with BMA regarding any relevant progressive rehabilitation and closure activities that may affect BMA-owned land.
3	**Licensees of Land within BWM EA Area**	Licensee	Private grazing business - TN & FL Richardson and AJ & DI Vipen	BMA & Whitehaven Blackwater engaged with licensees regarding licence terms and conditions, and matters relating to land use management, from time to time.	16 February 2024	Letter, via letter drop	Management and future use of BMA-owned land within the BWM EA area	No enquiries or feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	Licensees' interest in use of the land for grazing was considered in framing PMLUs.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	BMA will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
		Licensee - BK, DA & GK McKenzie and CD & LE Stewart	Private grazing business		16 March 2026	Meeting	Management and future use of WHC-owned land within the BWM EA area	No new feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	As below.	As below.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.

Blackwater Mine PRCP - Community Consultation Register

KEY STAKEHOLDERS WITH GENUINE INTEREST AND PREVIOUS ENGAGEMENT					COMMUNITY CONSULTATION REGISTER						
Priority	**Stakeholder Group**	**Stakeholder Title**	**Organisation**	**Previous Engagement / Stakeholder Context**	**Actual Consultation Date / Place**	**Consultation Type / Meeting Attendance (e.g. Community Member / Government rep., etc)**	**Information Provided**	**Issues Raised / Discussed (e.g. PMLU / NUMA)**	**How Issues were Considered**	**Decisions / Outcomes of Engagement (e.g. PLMU / NUMA Commitments)**	**Commitments (including Revised Design)**
		Licensee - BK, DA & GK McKenzie and CD & LE Stewart	Private grazing business		1 July 2025	Letter, via letter drop	Management and future use of WHC-owned land within the BWM EA area	No new feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	Licensees' interest in use of the land for grazing was considered in framing PMLUs.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
		Licensee - BK, DA & GK McKenzie and CD & LE Stewart	Private grazing business		16 February 2024	Letter, via letter drop	Management and future use of BMA-owned land within the BWM EA area	No enquiries or feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	Licensees' interest in use of the land for grazing was considered in framing PMLUs.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
		Licensee - Thomas and Christine Maree Boag	Private grazing business		1 July 2025	Meeting	Management and future use of BMA-owned land within the BWM EA area including PRCP Rev 2 and Rev 3.	No new feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	Licensees' interest in use of the land for grazing was considered in framing PMLUs.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
		Licensee - Thomas and Christine Maree Boag	Private grazing business		16 February 2024	Letter, via letter drop	Management and future use of BMA-owned land within the BWM EA area	No enquiries or feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	Licensees' interest in use of the land for grazing was considered in framing PMLUs.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
		Licensee - Comet Downs Cattle Company Pty Ltd	Private grazing business		16 March 2026	Meeting	Management and future use of WHC-owned land within the BWM EA area	No new feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	As below.	As below.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
		Licensee - Trevor & Fenella Neilson	Private grazing business		16 February 2024	Letter, via letter drop	Management and future use of BMA-owned land within the BWM EA area	No enquiries or feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	Licensees' interest in use of the land for grazing was considered in framing PMLUs.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
		Licensee - Trevor & Fenella Neilson	Private grazing business		16 February 2024	Letter, via letter drop	Management and future use of BMA-owned land within the BWM EA area	No enquiries or feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	Licensees' interest in use of the land for grazing was considered in framing PMLUs.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
		Licensee - IK & K McCamley	Private grazing business		1 July 2025	Meeting	Management and future use of BMA-owned land within the BWM EA area including PRCP Rev 2 and Rev 3.	No new feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	Licensees' interest in use of the land for grazing was considered in framing PMLUs.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
		Licensee - IK & K McCamley	Private grazing business		16 February 2024	Letter, via letter drop	Management and future use of BMA-owned land within the BWM EA area	No enquiries or feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	Licensees' interest in use of the land for grazing was considered in framing PMLUs.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
		Licensee - Bruce Robert Black	Private grazing business		16 February 2024	Letter, via letter drop	Management and future use of BMA-owned land within the BWM EA area	No enquiries or feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	Licensees' interest in use of the land for grazing was considered in framing PMLUs.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
		Licensee - Jem Family Trust (Jack Mayne)	Private grazing business		16 February 2024	Letter, via letter drop	Management and future use of BMA-owned land within the BWM EA area	No enquiries or feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	Licensees' interest in use of the land for grazing was considered in framing PMLUs.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
		Licensee - JM & LA Engwicht	Private grazing business		16 February 2024	Letter, via letter drop	Management and future use of BMA-owned land within the BWM EA area	No enquiries or feedback were received. Areas of interest as indicated in previous engagements include use of land within the EA area for grazing under a licence agreement.	Licensees' interest in use of the land for grazing was considered in framing PMLUs.	Grazing is considered as a PMLU in areas where disturbed land would be rehabilitated to enable this use.	Whitehaven Blackwater Pty. Ltd. will continue to engage with licensees regarding licence agreements, as and when affected by rehabilitation and/or closure activities, and will keep licensees updated on PRC plan implementation.
4	**BWM**	General Manager	BWM	BMA's Closure Planning Team had regular consultation with BWM's General Manager.	15 August 2025	Article in Employee Newsletter	PRCP Fact Sheet and Article	No issues raised or feedback provided	No issues raised	None	None
					1 February 2024	Meeting to discuss PRC planning requirements and support for communication with personnel.	Information was provided as for external stakeholders. Information was also provided on PRC Planning consultation requirements, and supporting information was provided to enable communication with BWM personnel.	PRC plan requirements Rehabilitation and post-mining land use Approved PMLUs Rehabilitation schedule	Agreement to ongoing engagement in PRC planning	Cooperation between BWM GM and the Whitehaven Blackwater Pty. Ltd.'s Closure Planning team will continue during PRC plan implementation and updates to the PRC plan	Whitehaven Blackwater Pty. Ltd. will involve the BWM GM in PRC planning, to build capacity for community engagement on PRC planning issues and support effective delivery of PRC plans.
		Mine personnel	BWM	BMA communicated with its personnel on a continual basis through toolbox talks, emails, safety meetings, Community Connect and Coal Connect, which are regular newsletters.	15 August 2025	Article in Employee Newsletter	PRCP Fact Sheet and Article	No issues raised or feedback provided	No issues raised	None	None

Blackwater Mine PRCP - Community Consultation Register

KEY STAKEHOLDERS WITH GENUINE INTEREST AND PREVIOUS ENGAGEMENT					COMMUNITY CONSULTATION REGISTER						
Priority	**Stakeholder Group**	**Stakeholder Title**	**Organisation**	**Previous Engagement / Stakeholder Context**	**Actual Consultation Date / Place**	**Consultation Type / Meeting Attendance (e.g. Community Member / Government rep., etc)**	**Information Provided**	**Issues Raised / Discussed (e.g. PMLU / NUMA)**	**How Issues were Considered**	**Decisions / Outcomes of Engagement (e.g. PLMU / NUMA Commitments)**	**Commitments (including Revised Design)**
					16 February 2024	Information provided for distribution to personnel through Coal Connect and BWM site newsletter	Coal Connect and site newsletter: - PRC plan requirements and timing for BWM - Commitment to progressive rehabilitation - PRC purpose and scope - Divestment timing and new Owner's role - Progress on BMA PRC planning for other assets - Opportunity to seek further information and discussion	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will keep the workforce updated as PRC plans are implemented and updated.	Whitehaven Blackwater Pty. Ltd. will keep the BWM workforce updated if there are changes to the PRC plan, and as the PRC Plan reaches its renewal date. Whitehaven Blackwater Pty. Ltd. will provide a communication channel for personnel to ask questions or contribute to discussions about PRC planning and rehabilitation.
5	**Local Government**	CEO Mayor Councillors	Central Highlands Regional Council (CHRC)	BMA had regular meetings with Council as well as meeting with Councillors and officers as-needed on specific issues. BMA provided a preliminary briefing to Council on PRC requirements in 2023.	24 July 2025	Email Phone Call	Overview of PRCP and consultation to date. Discussed purpose and requirement of consultation. Discussed broad feedback received to date. Stakeholder provided no feedback but advised they would discuss internally and update	No issues raised or feedback provided	No issues raised	None	None
					16 February 2024	Letter, via email and post	BWM location and approved activities Queensland Government requirements for mine rehabilitation and closure planning Scope and purpose of PRC plan Commitment to progressive rehabilitation Rehabilitation objective for BWM EP Act requirements for rehabilitation PRC plan requirements Progressive rehabilitation with disturbed areas rehabilitated as soon as practical Approved post mining land use options Inclusion of voids as non-use management areas Timeframe for BMA's divestment of BWM Transfer of mine operations and rehabilitation to new Owner Responsibility for future engagement on PRC plan Invitation to seek information or discussion	No feedback or enquiries were received.	The engagement processes for implementation and any updates to the PRC plan will include consultation with CHRC. CHRC's road reserves are within the EA area, which will need to be considered in PRC planning. Prior information and consultation will be required with CHRC regarding the future use of roads and road reserves within the EA area.	CHRC will require ongoing engagement regarding PRC planning for BWM. PRC planning updates will be provided at meetings between Whitehaven Blackwater Pty. Ltd. and CHRC. Whitehaven Blackwater Pty. Ltd. will also consult CHRC on management plans if rehabilitation and/or closure activities would impact on CHRC assets including road management and recycling facilities. Future engagement with Council will include discussion of rehabilitation methods and milestones.	Whitehaven Blackwater Pty. Ltd. will engage with CHRC to understand Council's strategic planning for Central Highlands LGA and the BWM project area as relevant. Whitehaven Blackwater Pty. Ltd. will work with CHRC to develop an agreement addressing any closure/rehabilitation impacts affecting Council-owned land, roads, road reserves or other assets (e.g. waste management facilities), as relevant, and will update CHRC on PRC planning regularly. Whitehaven Blackwater Pty. Ltd. will work with Council and other stakeholders in future PRC plan consultations to identify and implement shared value opportunities.
6	**Nearby Landowners (within 5 km)**	Owners of land within 5 km of EA area	Private landowners	There are 50 private owners of rural properties located within 5 km of BWM's EA area. Properties include large private landholdings (primarily grazing and dryland cropping) and smaller hobby farms/rural living lots. Nearby landowners include licensees of BMA-owned land. BMA engaged with nearby landowners through letters, emails and letter box drops, on an as-needed basis. Whitehaven Blackwater has continued to engage with these same landowners following the acquisition of Blackwater Mine in April 2024.	7-11 July 2025	Meetings with all neighbouring landholders within 5kms of Blackwater Mine Operations	Overview of PRCP. Discussed purpose and requirement of operations, rehabilitation and current closure planning	Desire to see more grazing Desire to see original grazing land returned to grazing country Questions around ongoing pest and weed management Questions on final landform and impact on local weather patterns Questions on remaining infrastructure	None	None	None
					Letter via email and post - 16 February 2024 Letter drop to Blackwater postcode 19 February 2024	Letter via post to five landholders Letter via email to five landholders Letter box drop to Blackwater postal area, inclusive of Blackwater township and private landholders within 5 km of EA area	Management and future use of BMA-owned land within the BWM EA area	No feedback or enquiries were received. BMA's regular engagements with landholders indicated that their issues of interest include environmental management, land access under current land access and lease agreements, and access to land for grazing use whilst is not required for mining.	No issues raised.	Information about PRC planning and implementation will be made available to nearby landowners through regular community updates.	Whitehaven Blackwater Pty. Ltd. will continue to inform and consult with nearby landowners during the process of implementing and updating PRC plans.
7	**Blackwater Community**	Blackwater residents, business owners, and community organisations and groups	Various - private home ownership, tenants, businesses and community organisations and groups	BMA communicated with Blackwater residents, businesses and community organisations through stakeholder meetings, media and social media, and Community Connect, a regular newsletter. BMA conducted a range of engagement activities with community members, from one-off responses to enquiries, to community events and forums, and ongoing engagement processes such as partnerships with community organisations and industry bodies. Whitehaven Blackwater has continued to engage with these same stakeholders following the acquisition of Blackwater Mine in April 2024.Whitehaven Blackwater has continued to engage with these same stakeholders following the acquisition of Blackwater Mine in April 2024.	26 March 2026	Blackwater Community Reference Group	Overview of PRCP Rev 3 and Blackwater North Extension Project and consultation to date. Discussed purpose and requirement of consultation. Discussed broad feedback received to date. Stakeholder provided no feedback.	No issues raised or feedback provided	No issues raised	None	None
					26 March 2026	Email + discussion with Council Representatives	Overview of PRCP Rev 3 and Blackwater North Extension Project and consultation to date. Discussed purpose and requirement of consultation. Discussed broad feedback received to date. Stakeholder provided no feedback.	No issues raised or feedback provided	No issues raised	None	None
					2 June 2025	Discussion with Mayor + Community Members on PRCP	High level discussion and introduction of PRCP upcoming engagement.	None	No issues raised	None	None
					7 August 2025	Email + discussion with Council Representatives	Overview of PRCP and consultation to date. Discussed purpose and requirement of consultation. Discussed broad feedback received to date. Stakeholder provided no feedback but advised they would discuss internally and update Further update to be provided at September CRG Meeting	No issues raised or feedback provided	No issues raised	None	None

Blackwater Mine PRCP - Community Consultation Register

KEY STAKEHOLDERS WITH GENUINE INTEREST AND PREVIOUS ENGAGEMENT					COMMUNITY CONSULTATION REGISTER						
Priority	**Stakeholder Group**	**Stakeholder Title**	**Organisation**	**Previous Engagement / Stakeholder Context**	**Actual Consultation Date / Place**	**Consultation Type / Meeting Attendance (e.g. Community Member / Government rep., etc)**	**Information Provided**	**Issues Raised / Discussed (e.g. PMLU / NUMA)**	**How Issues were Considered**	**Decisions / Outcomes of Engagement (e.g. PLMU / NUMA Commitments)**	**Commitments (including Revised Design)**
					19 February 2024 03 March 2024 16 February 2024 - 1 April 2024	Letter box drop to approximately 2,300 premises in the Blackwater Postal Area Inclusion of information in 'Community Connect' which is distributed to 15,000 households Information available through Community Team and Community Hotline	Letter as per content for underlying landowner and other stakeholders Community Connect and Community hotline: PRC plan requirements and timing for BWM Commitment to progressive rehabilitation PRC purpose and scope Divestment timing and new Owner's role Progress on BMA PRC planning for other assets Opportunity to seek further information and discussion	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will provide community updates on PRC planning for BWM if there are any substantive changes or updates to the PRC plan.	Whitehaven Blackwater Pty. Ltd. 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. This will include identifying local capacity for involvement in rehabilitation work. Whitehaven Blackwater Pty. Ltd. will participate in initiatives led by CHRC, industry or local communities which aim to harness social value from mine closure and rehabilitation planning, and/or work towards from economic transformation.
8	**Central Highlands Community Groups and Businesses**	Community Groups and Businesses in the Central Highlands Region	Central Highlands Development Corporation	BMA engaged regularly with CHDC over the years, on a broad range of topics. BMA provided a preliminary overview of PRC planning requirements to CHDC in 2023. Whitehaven Blackwater has continued to engage with these same stakeholders following the acquisition of Blackwater Mine in April 2024.	7 August 2025	Email + discussion with Peter Dowling	Overview of PRCP and consultation to date. Discussed purpose and requirement of consultation. Discussed broad feedback received to date. Stakeholder provided no feedback but advised they would discuss internally and update. Further update to be provided at September CRG Meeting	No issues raised or feedback provided	No issues raised	None	None
					16 February 2024	Letter, via email	As above	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will continue to provide community information and opportunities for feedback as part of future PRC planning processes.	Whitehaven Blackwater Pty. Ltd. will continue to provide community information and opportunities for feedback as part of future PRC planning processes via letter or meetings.
9	**Utility owners**	Commercial Customers Manager	Sunwater	Sunwater's Blackwater Pipeline is located within the EA area. BMA's engagement with Sunwater was on an as-needed basis with respect to commercial arrangements.	16 February 2024	Letter, via email	As above	No feedback or enquiries were received.	Sunwater's Blackwater Pipeline is within the EA area, which will need to be considered in PRC planning.	Whitehaven Blackwater Pty. Ltd. will maintain correspondence with Sunwater regarding progressive rehabilitation activities as they affect the Blackwater Pipeline, and undertake consultation regarding crossing/interface agreements, if required.	Whitehaven Blackwater Pty. Ltd. will work with Sunwater to develop an agreement addressing any closure/rehabilitation impacts affecting the Blackwater Water Pipeline, as relevant.
		Manager Project Planning and Corridor Management	DTMR	DTMR owns the Capricorn Highway and Ardurad (Blackwater-Rolleston) Road. BMA's engagement with DTMR was on an as-needed basis with respect to road interface and usage arrangements.	16 February 2024	Letter, via email	As above	Acknowledgement of letter. Noted that In the vicinity of the mine, DTMR are responsible for Ardurad (Blackwater-Rolleston) Road and the Capricorn Highway.	The location and use of Capricorn Highway and Ardurad (Blackwater-Rolleston) Road will need to be considered in PRC planning.	Whitehaven Blackwater Pty. Ltd. will maintain correspondence with DTMR regarding progressive rehabilitation activities as they affect Capricorn Highway and Ardurad (Blackwater-Rolleston) Road, and undertake consultation regarding crossing/interface agreements, if required.	Whitehaven Blackwater Pty. Ltd. will work with DTMR to develop an agreement addressing any closure/rehabilitation impacts affecting the Capricorn Highway and/or Ardurad (Blackwater-Rolleston) Road, as relevant.
		Senior Designer, Mackay/Whitsunday District	Queensland Rail	Queensland Rail owns four railways (Central, South Blackwater Mine, Blackwater Mine and Bauhinia), as well as two loops and two sidings, in the vicinity of the BWM EA area. BMA engagement with Queensland Rail included routine correspondence on commercial and statutory issues, with meetings held as required on specific issues.	16 February 2024	Letter, via email and post	As above	No feedback or enquiries were received.	Prior information and consultation will be required with Queensland Rail regarding the use and, as relevant, decommissioning of rail infrastructure within the EA area.	Whitehaven Blackwater Pty. Ltd. will advise Queensland Rail of any substantive changes to closure planning or the rehabilitation schedule as part of future PRC planning processes for BWM.	Whitehaven Blackwater Pty. Ltd. will maintain engagement with Queensland Rail regarding its progressive rehabilitation activities as they affect Queensland Rail assets, and undertake engagement regarding the decommissioning of rail infrastructure prior to its closure, in accordance with agreements between Whitehaven Blackwater Pty. Ltd. and Queensland Rail at the time.
		Senior Business Analyst, Network Asset Management	Aurizon Network	Aurizon Network operates Queensland Rails' assets in the vicinity of the BWM EA area. BMA engagement with Aurizon included routine correspondence on commercial and statutory issues, with meetings held as required on specific issues.	16 February 2024	Letter, via email and post	As above	No feedback or enquiries were received.	Prior information and consultation will be required with Aurizon Network regarding the use and, as relevant, decommissioning of rail infrastructure within the EA area.	Whitehaven Blackwater Pty. Ltd. will advise Aurizon Network of any substantive changes to closure planning or the rehabilitation schedule as part of future PRC planning processes for BWM.	Whitehaven Blackwater Pty. Ltd. will maintain engagement with Aurizon Network regarding its progressive rehabilitation activities as they affect rail operation, in accordance with agreements between Whitehaven Blackwater Pty. Ltd. and Aurizon Network at the time.
		Major Customer Manager	Ergon Energy Corporation Ltd	Ergon Energy owns 22kV Feeders, 66kV Transmission Lines, substations and the Rolleston 132kV Transmission Line. BMA engagement with Ergon included routine correspondence on commercial and statutory issues.	16 February 2024	Letter, via email	As above	Acknowledgement of letter received. No feedback or enquiries were received.	No issues raised. Prior information and consultation will be required with Ergon Energy regarding the decommissioning/future use of power easements within the EA area, as relevant.	Whitehaven Blackwater Pty. Ltd. will maintain correspondence with Ergon Energy regarding progressive rehabilitation activities as they affect Ergon Energy assets, and undertake consultation regarding agreements about energy infrastructure, if required.	Whitehaven Blackwater Pty. Ltd. will advise and consult Ergon Energy regarding any impacts of closure/rehabilitation activities that may affect Ergon Energy's assets.
		Property Services and Management Team Leader	Powerlink	Powerlink owns 132kV Transmission Lines. BMA engagement with Powerlink included routine correspondence on commercial and statutory issues.	16 February 2024	Letter, via email	As above	No feedback or enquiries were received.	Prior information and consultation will be required with Powerlink regarding the decommissioning/future use of power easements within the EA.	Whitehaven Blackwater Pty. Ltd. will maintain correspondence with Powerlink regarding progressive rehabilitation activities as they affect Powerlink assets, and undertake consultation regarding crossing/interface agreements, if required.	Whitehaven Blackwater Pty. Ltd. will advise and consult Powerlink regarding any impacts of closure/rehabilitation activities that may affect Powerlink's assets.
		Sales Operations Manager	Telstra Amplitel	Telstra Amplitel owns three microwave towers within the EA area. There are no records of specific engagement with Telstra Amplitel regarding BWM.	16 February 2024	Letter, via email	As above	No feedback or enquiries were received.	Prior information and consultation will be required with Telstra Amplitel regarding the decommissioning/future use of telecommunications infrastructure within the EA area.	Whitehaven Blackwater Pty. Ltd. will maintain correspondence with Telstra Amplitel regarding progressive rehabilitation activities as they affect Telstra Amplitel assets, and undertake consultation about telecommunications infrastructure agreements, if required.	Whitehaven Blackwater Pty. Ltd. will advise and consult Telstra Amplitel regarding any impacts of closure/rehabilitation activities that may affect their assets.

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		Head of Land Access, Major Projects	Telstra Vocus	Telstra Vocus owns a WiFi installation within the EA area. There are no records of specific engagement with Telstra Vocus regarding BWM.	16 February 2024	Letter, via email and post	As above	No feedback or enquiries were received.	Prior information and consultation will be required with Telstra Vocus regarding the decommissioning/future use of telecommunications infrastructure within the EA area, as relevant.	Whitehaven Blackwater Pty. Ltd. will maintain correspondence with Telstra Vocus regarding progressive rehabilitation activities as they affect Telstra Vocus's asset, and undertake consultation about internet infrastructure agreements, if required.	Whitehaven Blackwater Pty. Ltd. will advise and consult Telstra Vocus regarding any impacts of the closure/rehabilitation activity that may affect their assets.
		Senior Development Manager - REN Australia	Total Energies	Total Energies hold a development approval on 13HT602 adjacent to the EA area for the development and operation of a solar farm. The solar farm is yet to be installed.	22 February 2024	Letter, via email	As above	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will advise Total Energies, as an adjoining landholder, of any substantive changes to the closure or rehabilitation schedule as part of future PRC planning processes for BWM.	Whitehaven Blackwater Pty. Ltd. will advise Total Energies of any substantive changes to closure or rehabilitation schedule as part of future PRC planning processes for BWM.
10	**Adjacent and Nearby Mining Interests**	Tenement Manager	QCoal Services Pty Ltd	BWM's GM engaged with Cook's Colliery's General Manager on an as-needed basis, through emails, phone calls and meetings. QCoal and BMA had an agreement to use BWM MLs to access the Cook's Colliery mine. This agreement was transferred to Whitehaven Blackwater. BMA engaged with QCoal as part of commercial and infrastructure agreements.	21 February 2024	Letter via email	As above	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will keep QCoal updated as PRC Plans are implemented and revised.	Whitehaven Blackwater Pty. Ltd. will keep QCoal updated if there are substantive future changes to the PRC plan.
		Manager, Mine Engineering	Coronado Global Resources Inc.	Curragh Mine is located to the north of BWM. BMA had a good neighbour agreement with Coronado Global Resources Inc., including the accommodation of the East Bedford water pipeline. This agreement was transferred to Whitehaven Blackwater.	21 February 2024	Letter via email	As above	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will keep Coronado Curragh Pty. Ltd updated as PRC Plans are implemented and revised.	Whitehaven Blackwater Pty. Ltd. will keep Coronado Curragh Pty. Ltd. updated if there are substantive future changes to the PRC plan, and as the PRC Plan reaches its renewal date.
11	**Petroleum Tenement Holders**	Tenement Manager/Authorised Holder Representative	Bow CSG Pty. Ltd.	Bow CSG hold an Authority to Prospect and Petroleum Commercial Area which include land within ML 1759 and ML1761. Both MLs were granted prior to the enactment of the Mineral and Energy Resources (Common Provisions) Act 2014, and both hold gaseous hydrocarbons rights. Where overlapped by these ATPs, the petroleum resource authority does not hold rights to access the hydrocarbons. BMA and Bow CSG communicated regarding tenure issues on an as-needed basis.	14 March 2024	Letter, via email	As above	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will advise Bow CSG Pty. Ltd of any substantive changes to the closure or rehabilitation schedule as part of future PRC planning processes for BWM.	Whitehaven Blackwater Pty. Ltd. will advise Bow CSG Pty. Ltd of any substantive changes to closure or rehabilitation schedule as part of future PRC planning processes for BWM.
		Tenement Manager/Authorised Holder Representative	Comet Ridge Mahalo North Pty Ltd, Comet Ridge Mahalo Far East Pty Ltd and Comet Ridge Mahalo East Pty Ltd hold	Comet Ridge Mahalo entities hold three ATPs (ATP 2061, ATP 2048, ATP 2063) and PLA 1128 which includes land within the EA area in the north and east. As above, the BMA resource authorities hold gaseous hydrocarbon rights and therefore, where overlapped by these ATPs, the petroleum resource authority does not hold rights to access the hydrocarbons. BMA and Comet Ridge Mahalo entities communicated on an as-needed basis. BMA also engaged with Comet Ridge Maholo in relation to the Blackwater South Mining Lease applications.	14 March 2024	Letter, via email	As above	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will advise Comet Ridge Mahalo entities of any substantive changes to the closure or rehabilitation schedule as part of future PRC planning processes for BWM.	Whitehaven Blackwater Pty. Ltd. will advise Comet Ridge Mahalo entities of any substantive changes to closure or rehabilitation schedule as part of future PRC planning processes for BWM.
		Tenement Manager/Authorised Holder Representative	Bronco Energy Pty Limited	Bronco Energy hold ATP804 and PCA 215 which are adjacent to the EA area. BMA did not have previous engagement with Bronco Energy regarding BWM.	14 March 2024	Letter, via email	As above	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will advise adjacent petroleum tenement holders of any substantive changes to the closure or rehabilitation schedule as part of future PRC planning processes for BWM.	Whitehaven Blackwater Pty. Ltd. will advise adjacent petroleum tenement holders of any substantive changes to the closure or rehabilitation schedule as part of future PRC planning processes for BWM.
		Tenement Manager/Authorised Holder Representative	Santos QNT. Pty. Ltd.	Santos QNT. Pty. Ltd. hold ATPs and production licences to the south of the EA area (ATP 1191, PL 1082, PL 1083, PSL 2058, PL 1082, PL 1083). BMA engaged with Santos in relation to the Blackwater South Mining Lease applications.	14 March 2024	Letter, via email	As above	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will advise adjacent petroleum tenement holders of any substantive changes to the closure or rehabilitation schedule as part of future PRC planning processes for BWM.	Whitehaven Blackwater Pty. Ltd. will advise adjacent petroleum tenement holders of any substantive changes to the closure or rehabilitation schedule as part of future PRC planning processes for BWM.
12	**Queensland Government**	PRC Planning Team Regional Director Queensland Parks and Wildlife Service and Partnerships - Mackay	Department of Environment, Tourism, Science and Innovation (DETSI)	BMA & Whitehaven Blackwater engaged with DETSI through meetings and correspondence regarding the preparation and delivery of the PRC Plan. BMA did not have an active relationship with QPSWSP with respect to BWM.	Meetings per schedule as agreed with DETSI	Pre-lodgement meetings	Provision of draft PRC Plan and discussion of requirements	As per pre-lodgement meetings.	DESI feedback was considered in the development of the PRC Plan including the Community Consultation Plan	The PRC plan will be completed in accordance with Whitehaven Blackwater's agreements with DETSI.	Whitehaven Blackwater Pty. Ltd. will comply with the legislative and regulatory requirements for PRC Plans.
					7 March 2024	Letter via post	BWM location and approved activities Queensland Government requirements for mine rehabilitation and closure planning Scope and purpose of PRC plan BMA's commitment to progressive rehabilitation Rehabilitation objective for BWM EP Act requirements for rehabilitation PRC plan requirements Progressive rehabilitation with disturbed areas rehabilitated as soon as practical Approved post mining land use options Inclusion of voids as non-use management areas Timeframe for BMA's divestment of BWM Transfer of mine operations and rehabilitation to new Owner Responsibility for future engagement on PRC plan Invitation to seek information or discussion	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will continue to provide information to interested government agencies and opportunities for feedback as part of future PRC planning processes.	Whitehaven Blackwater Pty. Ltd. will continue to provide information to interested government agencies and opportunities for feedback as part of future PRC planning processes.

Blackwater Mine PRCP - Community Consultation Register

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		Deputy Director-General Georesources Acting Director Native Title Services and Coal Hub, Rockhampton Executive Director, Minerals and Coal	Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development	BMA provided briefings to the Deputy Director-General Georesources on an as-needed basis, and met and corresponded with Department of Resources regarding resource development commitments. Department of Resources is the owner of a stock route (416CENT, 348CENT, 413CENT, 353CENT) within the EA area. BMA provided briefings to the Acting Director Native Title Services and Coal Hub on an as-needed basis, and met and corresponded with Department of Resources regarding resource development commitments.	16 February 2024	Letter via email	BWM location and approved activities Queensland Government requirements for mine rehabilitation and closure planning Scope and purpose of PRC plan BMA's commitment to progressive rehabilitation Rehabilitation objective for BWM EP Act requirements for rehabilitation PRC plan requirements Progressive rehabilitation with disturbed areas rehabilitated as soon as practical Approved post mining land use options Inclusion of voids as non-use management areas Timeframe for BMA's divestment of BWM Transfer of mine operations and rehabilitation to new Owner Responsibility for future engagement on PRC plan Invitation to seek information or discussion	Acknowledgement of correspondence. No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will provide a copy of the BWM PRC plan to DDG Georesources, and update the DDG Georesources on any substantive future changes to the PRC Plan. The PRC Plan's Community Consultation Plan includes provision of annual updates to Department of Resources. Whitehaven Blackwater Pty. Ltd. will provide a copy of the BWM PRC plan to the Director Native Title Services and Coal Hub, Rockhampton, and provide updates on any substantive future changes to the PRC Plan. Whitehaven Blackwater Pty. Ltd. will provide a copy of the BWM PRC plan to the Executive Director, Minerals and Coal, and provide updates on any substantive future changes to the PRC Plan.	Whitehaven Blackwater Pty. Ltd. will provide annual updates on PRC planning to the Deputy Director General, Georesources. Whitehaven Blackwater Pty. Ltd. will provide updates on PRC planning to the Director Native Title Services and Coal Hub, Rockhampton as requested. Whitehaven Blackwater Pty. Ltd. will provide updates on PRC planning to the Executive Director, Minerals and Coal, as requested.
		Deputy Director-General, Fisheries and Forestry	Department of Primary Industries	BMA did not have an active relationship with the Department of Primary Industries with respect to BWM.	16 February 2024	Letter, via email and post	As above	Acknowledgement of letter received. No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will continue to provide information and opportunities for feedback to Department of Agriculture and Fisheries as part of future PRC planning processes.	Whitehaven Blackwater Pty. Ltd. will provide updates on PRC planning to the DDG Fisheries and Forestry. as requested.
13	**Queensland Parliamentary Representatives**	Sean Dillon MP	Queensland Parliament - Member for Gregory	BMA provided briefings to the Member for Gregory's office on an as-needed basis.	29 July 2025	Email	Factsheet	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will update the local member on any substantive future changes to the PRC Plan.	Whitehaven Blackwater Pty. Ltd. will provide updates on PRC planning to the local member as requested.
14	**Federal Government**		Office of the Minister and Dep. Sec. Environment Protection, Department of Climate Change, Energy, the Environment and Water	BMA provided briefings to the Minister's office on an as-needed basis.	As part of regular meetings	Discussion of PRC plans as part of a future briefing	As above	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will update the Office of the Minister on any substantive future changes to the PRC Plan.	Whitehaven Blackwater Pty. Ltd. will provide updates on PRC planning to the Minister's office as requested.
15	**Federal Parliamentary Representatives**	Colin Boyce MP	Federal Parliament - Member for Flynn	Nil	29 July 2025	Email	Factsheet	No feedback or enquiries were received.	No issues raised.	Whitehaven Blackwater Pty. Ltd. will update the local member on any substantive future changes to the PRC Plan.	Whitehaven Blackwater Pty. Ltd. will provide updates on PRC planning to the local member as requested.

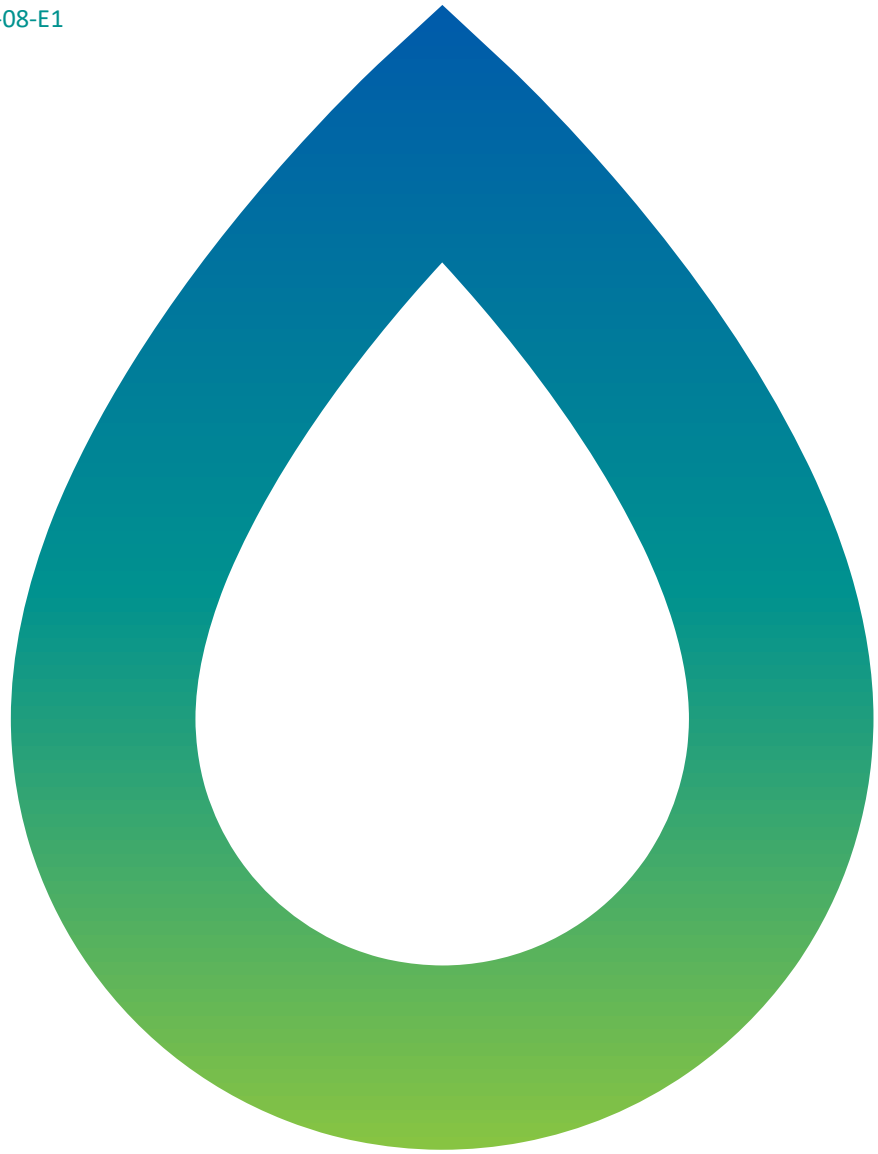
BLACKWATER MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN

Voids in Floodplain Modelling

Whitehaven Coal Limited

28 May 2026

1559-08-E1



DETAILS

Report Title	Blackwater Mine Progressive Rehabilitation and Closure Plan, Voids in Floodplain Modelling
Client	Whitehaven Coal Limited

THIS REVISION

Report Number	1559-08-E1
Date	28 May 2026
Author	Lorena Miranda; Trang Nguyen
Reviewer	Ardianto Notodirdjo

NOTE: This report has been prepared on the assumption that all information, data and reports provided to us by our client, on behalf of our client, or by third parties (e.g. government agencies) is complete and accurate and on the basis that such other assumptions we have identified (whether or not those assumptions have been identified in this advice) are correct. You must inform us if any of the assumptions are not complete or accurate. We retain ownership of all copyright in this report. Except where you obtain our prior written consent, this report may only be used by our client for the purpose for which it has been provided by us.

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1 INTRODUCTION

1.1 OVERVIEW

Whitehaven, the owners of Blackwater Mine (BWM), has requested WRM Water & Environment Pty Ltd (WRM) to undertake hydrologic and hydraulic modelling to define the floodplain at BWM, to supplement the BWM Progressive Rehabilitation and Closure Plan (PRCP). BWM requires a PRCP to be completed in accordance with BWM's Environmental Authority (EA) (EPML00717813), and PRCP Guideline Requirements.

As part of the PRCP for BWM, it is proposed to incorporate 15 final voids as Non-use Management Areas (NUMAs). Figure 1.1 and Figure 1.2 show the pre-mining conditions drainage characteristics of the study area as well as the locations and extents of the proposed final voids at BWM.

This "Void in Floodplain Modelling" report was prepared to address the requirements in Section 3.4 – General rehabilitation practices (flooding) of the Department of Environment, Tourism, Science and Innovation (DETSI) (formally the Department of Environment, Science and Innovation) Progressive rehabilitation and closure plans (PRC plans) guideline (Version 3.01) (DETSI, 2024), as well as the Information Sheet - Void in flood plains.

This study was undertaken to identify if the proposed final voids in the BWM final landform would be situated wholly or partially in a "flood plain", defined in PRCP guideline (DETSI, 2024) as land that is the same height as, or lower than, the level modelled as the peak water level during a 0.1% (1 in 1,000) annual exceedance probability (AEP) flood event for a relevant watercourse.

1.2 METHOD OF ASSESSMENT

1.2.1 Relevant watercourses

DETSI (2024) require floodplain modelling to be undertaken only for a "relevant watercourse", which is defined as those watercourses that are classified as stream order 4 or higher under the Strahler stream order classification system. A review of the Strahler Stream Order classifications within the study area, under pre-mining conditions, indicate that the following watercourses are of Strahler stream order 4 or greater and are therefore considered as relevant watercourses for the purpose of this study (refer to Figure 1.1):

- Blackwater Creek;
- Two Mile Gully;
- Taurus Creek (downstream of the Emu Creek confluence); and
- Sirius Creek.

Therefore, hydrologic and hydraulic modelling was undertaken for the above relevant watercourses.

1.2.2 Artificial features

DETSI (2024) require floodplain modelling to be undertaken to represent the flood plain at the time that all temporary structures or features have been removed. Hence, floodplain hydraulic modelling was undertaken by excluding any levees, mining pits, overburden dumps, stream diversion channels as well as road, rail and cross drainage infrastructure within the BWM mine lease area.

1.2.3 Hydrologic and hydraulic modelling

SLR previously prepared the flood assessments for previous version of the BWM final landform (SLR, 2024a and 2024b). In the SLR (2024a and 2024b) studies, hydrologic modelling was undertaken using XP-RAFTS and hydraulic modelling was undertaken using TUFLOW. The SLR (2024a and 2024b) flood

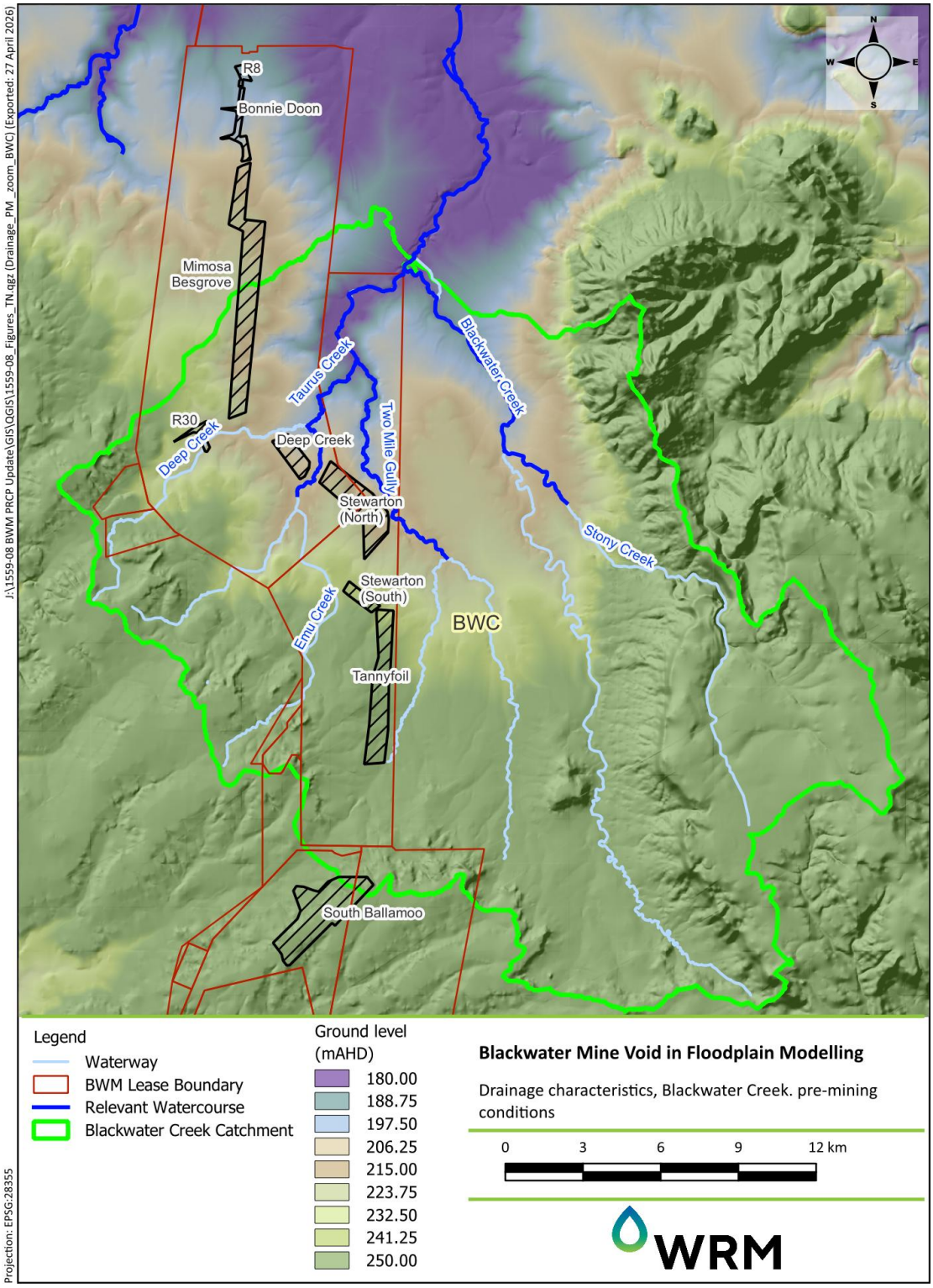


Figure 1.1 Drainage characteristics under pre-mining conditions, and the locations of the proposed final voids in the vicinity of Taurus Creek, Two Mile Gully and Blackwater Creek

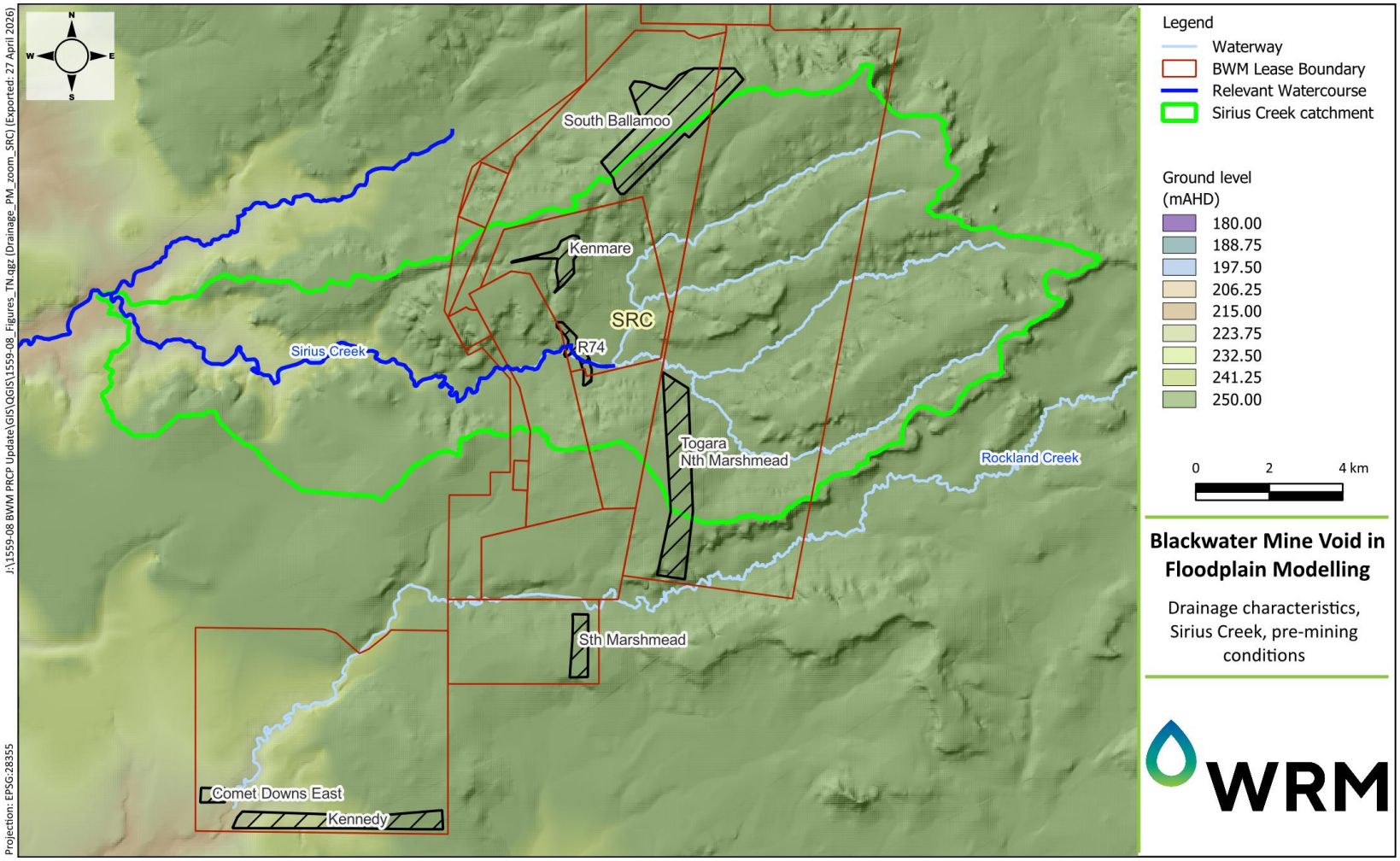


Figure 1.2 Drainage characteristics under pre-mining conditions, and the locations of the proposed final voids in the vicinity of Sirius Creek

models were developed based on the XP-RAFTS and TUFLOW models originally developed by GHD for the 2021 Blackwater Mine Flood Study (GHD, 2021).

For this study, new hydrologic models were developed using the URBS software package, which incorporates the latest climate change guidance from Australian Rainfall and Runoff 2019 Version 4.2 (ARR 2019 v4.2) (Ball et al, 2019). The URBS models were calibrated to recorded rainfall and water level data for the March 2017 and January 2020 events where suitable data is available. Details of the URBS model development and calibration are documented in the Hydrologic Model Development and Calibration Report provided in Appendix B.

The SLR (2024a and 2024b) TUFLOW hydraulic models were updated to incorporate the updated design discharges from the URBS hydrologic models. Hydrologic and hydraulic modelling were undertaken for the 0.1% AEP event.

1.3 REPORT STRUCTURE

The report is structured as follows:

- Section 2 is an overview of the data available for this study;
- Section 3 describes the estimation of design discharges;
- Section 4 describes the hydraulic model development;
- Section 5 presents the hydraulic modelling results;
- Section 6 presents a summary of the findings; and
- Section 7 is a list of references.

2 AVAILABLE DATA

2.1 OVERVIEW

Available data for this study was provided by Whitehaven and consisted of:

- Previous hydrologic and hydraulic studies;
- Recorded rainfall and water level data;
- LiDAR topographic data; and
- Proposed final landform surface.

2.1.1 Blackwater Mine Flood Study (2021)

The Blackwater Mine Flood Study undertaken by GHD (2021) assessed existing flood risks across BWM. XP-RAFTS hydrologic and TUFLOW hydraulic models were developed for this study. In this study, the hydrologic models for Burngrove Creek and Speculation Creek were calibrated to recorded water level data. The GHD (2021) study report was provided for this study, but the XP-RAFTS and TUFLOW models were not available.

2.1.2 Blackwater Mine Progressive Rehabilitation and Closure Plan (2024)

The XP-RAFTS hydrologic and TUFLOW hydraulic models used by SLR (2024a and 2024b) for the previous PRCP flood assessment were provided for this study. These models appear to have been developed based on the GHD (2021) hydrologic and hydraulic models. Separate models were provided for the Blackwater Creek and Sirius Creek catchments.

2.2 TOPOGRAPHIC DATA

The available topographic data used for this study is described as follows:

- A 1 m resolution LiDAR covering the BWM mine lease area captured in February 2024 (referred to as the 2024 LiDAR data);
- Topographic data embedded in the SLR (2024) TUFLOW hydraulic models;
- A 30 m resolution Copernicus Digital Surface Model (DSM) satellite ground level observation data obtained from the European Space Programme on 31 January 2025 (referred to as the Copernicus DSM data); and
- The Fitzroy River catchment 25 m resolution Digital Elevation Model (DEM) embedded in the SLR (2024a) hydraulic model supplied by Whitehaven.

Limited topographic data representing the pre-mining conditions within the BWM mine lease area was available for this study. The available 1 m LiDAR topographic data are generally representative of pre-mining topography outside of the BWM. Therefore, the available detailed LiDAR data was not used within the BWM mine lease area.

The Fitzroy River catchment 25 m resolution DEM provides the best representation of pre-mining topography within the BWM mine lease area and was therefore adopted in this study only for areas within BWM for the purpose of hydrologic and hydraulic modelling.

2.3 RAINFALL AND WATER LEVEL DATA

Whitehaven supplied recorded rainfall data from three subdaily rainfall (pluviograph) stations and recorded water level data for six stream gauging stations across BWM. Rating curves were also provided for the stream gauging stations. The data was used to calibrate the URBS hydrologic models.

Details of the station locations, the recorded data and the stream gauge rating curves are described in the Hydrologic Model Development Report in Appendix B.

3 ESTIMATION OF DESIGN DISCHARGES

3.1 OVERVIEW

3.1.1 Development and calibration of seven URBS hydrologic models

Two URBS models were developed for the Blackwater Creek (including Taurus Creek and Two Mile Gully) and Sirius Creek catchments. The Blackwater Creek (including Taurus Creek and Two Mile Gully) and Sirius Creek URBS models were calibrated to recorded data for the April 2017 and January 2020 flood events.

Design discharges for the 1% AEP event from the seven URBS models were validated against estimates derived using the Rational Method, the Quantile Regression Technique (QRT) and the Regional Flood Frequency Estimation (RFFE) method. The purpose of the model validation is to derive appropriate initial losses (ILs) and continuing losses (CLs) for the seven models.

The hydrologic model development, calibration and validation are described in detail in the "Hydrologic Model Development and Calibration Report" given in Appendix B. The estimation of validation of design discharges were undertaken based on current (year 2025) catchment and climate conditions.

3.1.2 Modification of URBS hydrologic models for final landform conditions

For the void in floodplain modelling assessment, the calibrated and validated URBS models were modified to reflect catchment conditions for pre-mining conditions. That is, the URBS model subcatchment boundaries were adjusted to reflect pre-mining conditions.

The modified hydrologic models were then used to derive design discharges for the 0.1% AEP flood event for pre-mining conditions. Details of hydrologic model development are provided below. Design discharges for pre-mining conditions were derived based on current (year 2025) climate conditions.

3.2 HYDROLOGIC MODEL CONFIGURATION

3.2.1 Subcatchment parameters

The boundaries of the URBS subcatchments were adjusted to represent the pre-mining conditions of the Blackwater Creek (BWC) and Sirius Creek (SRC) catchments (see Figure A.1 and Figure A.2 in Appendix A. The URBS model parameters were updated to reflect the changes in the catchment area, slope, imperviousness, and roughness values. The boundaries of the pre-mining conditions subcatchments were delineated based on the 25 m Fitzroy River catchment DEM provided by Whitehaven. A summary of model parameters is given in Table A.1 and Table A.2 in Appendix A.

3.2.2 Adopted global URBS model parameters

The global URBS model parameters, including channel lag parameter (alpha), catchment storage parameter (beta), catchment non-linearity (M) and channel routing exponent (N) for all seven hydrologic models are given below and were unchanged from the calibrated/validated hydrologic models.

- Channel routing "alpha" (α) = 0.1
- Catchment routing "beta" (β) = 1.0
- Catchment routing exponent (M) = 0.715
- Channel routing exponent (N) = 1.0

3.3 DESIGN RAINFALLS

3.3.1 Design rainfall depths

Design rainfall intensity-frequency-duration (IFDs) for the 0.1% AEP design event was obtained from the Bureau of Meteorology (BoM). Aerial Reduction Factors (ARFs) were applied to the design rainfalls for each model based on a focal point at the location of the proposed voids in each catchment.

3.3.2 Temporal patterns

The Jordan (2005) temporal patterns were adopted for durations up to 9 hours. The *Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method* (GTSMR) (BoM, 2005) temporal patters were adopted for durations longer than 9 hours.

3.3.3 Adjustment for climate change

Based on the latest guidance on climate change provided in ARR 2019 v4.2, global temperatures have already risen since the baseline historical rainfall data midpoint of 1961-1990. Therefore, to derive design rainfalls representative of current (year 2025) conditions, design rainfall estimates require factoring up to account for this temperature increase that has already occurred.

Design Intensity-Frequency-Duration (IFD) design rainfall intensities were scaled up using uplift factors obtained from ARR datahub[1], corresponding to the SSP5-8.5 (year 2030) climate scenario. The associated pre-burst rainfalls were also scaled up accordingly.

The SSP5-8.5 climate adjustments account for approximately 1.3°C of global warming up to 2025 since the historical baseline period of 1961-1990. Table 3.1 shows the corresponding 1% AEP design rainfall uplift factors for various storm durations (as percentage increases compared to the baseline).

Table 3.1 Adopted design rainfall uplift factors (SSP5-8.5 year 2030)

Storm duration	Rainfall uplift factor
<1 hour	20%
1.5 Hours	18%
2 Hours	17%
3 Hours	16%
4.5 Hours	14%
6 Hours	13%
9 Hours	13%
12 Hours	12%
18 Hours	11%
>24 Hours	11%

[1] https://data.arr-software.org/

3.3.4 Losses

For the 0.1% AEP event, a conservative approach was adopted by adopting an IL of 0 mm and CL of 1 mm/h. These are the losses recommended in ARR 2019 for the Probable Maximum Flood (PMF) design event.

3.4 HYDROLOGIC MODEL RESULTS

The URBS model predicted design peak discharges, critical storm durations and representative temporal patterns for the 0.1% AEP event for pre-mining conditions at key reporting locations are summarised in Table 3.2. The key reporting locations are shown in Figure 3.1.

Table 3.2 URBS output hydrographs, pre-mining conditions

Model	Location	0.1% AEP event		
		Critical duration (hours)	Peak discharge (m^3/s)	Representative temporal pattern
Blackwater Creek (BWC)	BWC_03	4.5h	1,062	4
	TRM2	6h	1,831	4
	BWC_706	9h	2,017	9
	BWC_Out	9h	3,180	4
Sirius Creek (SRC)	SRC_01	2h	1,740	4

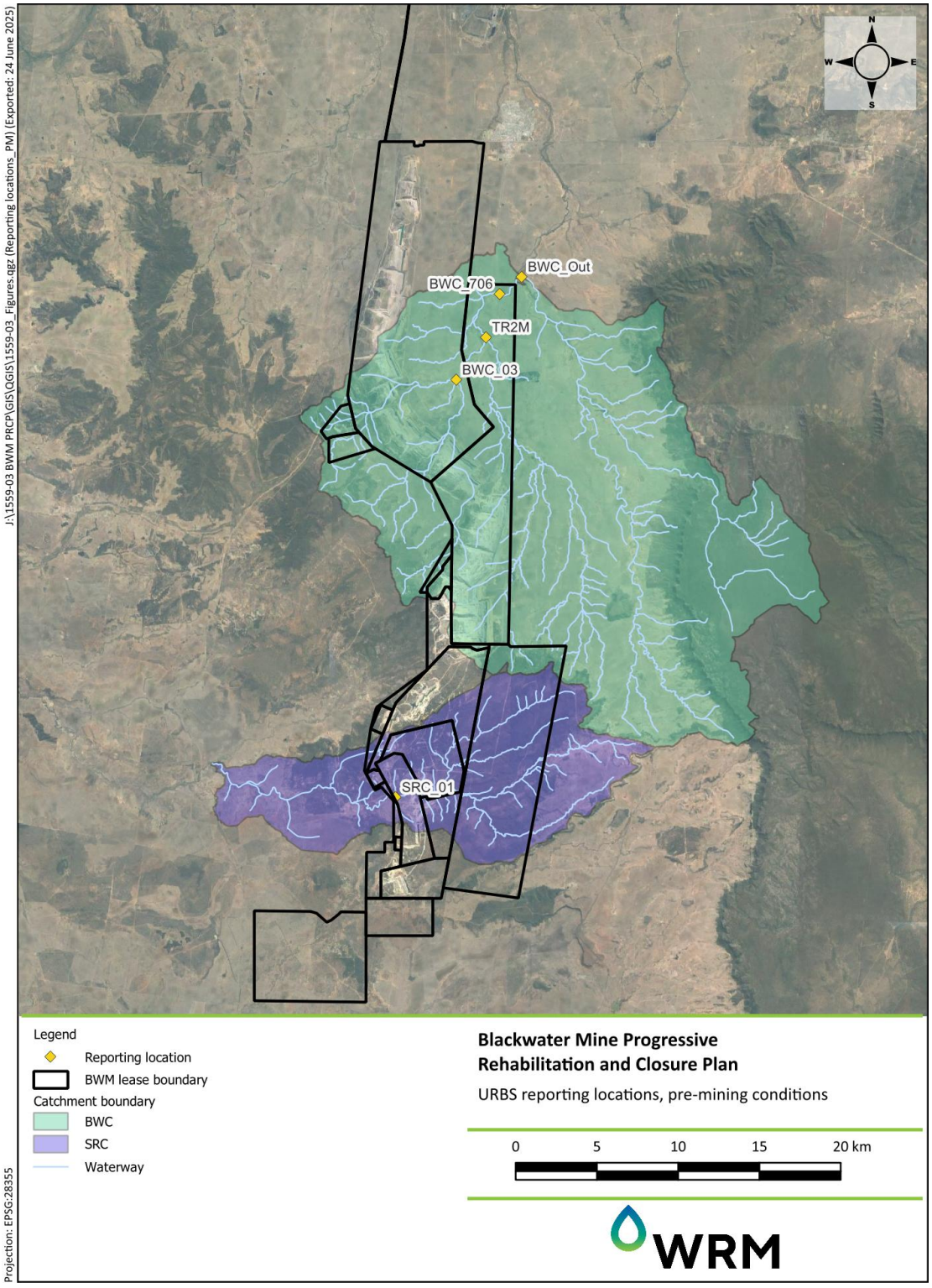


Figure 3.1 URBS design discharge reporting locations

4 HYDRAULIC MODELLING

4.1 OVERVIEW

The TUFLOW hydraulic models originally developed by SLR (2024b) were updated to represent the pre-mining conditions within the Blackwater Creek and Sirius Creek catchments. (Figure 4.1 and Figure 4.2).

Changes to the SLR (2024) model configuration are summarised as follows:

- Refinements of the model code boundary to reflect the modelled areas;
- Updates to the model inflow boundary conditions to reflect revised URBS hydrological model inputs; and
- Updates to the model topography using more detailed resolution data where available.

The TUFLOW hydraulic models were run for a series of key storm durations and temporal patterns selected based on the URBS hydrologic model results, as well as preliminary hydraulic modelling. The hydraulic model results were then used to characterise design flood depths, levels, extents and velocities for 0.1% AEP design event under pre-mining conditions.

4.2 MODEL CONFIGURATION

4.2.1 Model extent, resolution and topography

A 5 m grid cell TUFLOW model was developed for the Blackwater Creek (BWC) and Sirius Creek (SRC) catchments. Figure 4.1 and Figure 4.2 show the pre-mining conditions TUFLOW model configuration and extent for BWC and SRC, respectively. The models were configured with a grid cell size of 5 m. The models cover an area of 102 km^2 and 44 km^2 for BWC and SRC, respectively.

The pre-mining conditions model topography was configured using the following data:

- The 25 m Fitzroy River catchment DEM for areas within the BWM mine lease boundary;
- Detailed 1 m LiDAR topographic for areas outside of the BWM mine lease area where available; and
- The 30 m resolution Copernicus DEM for areas outside of the BWM mine lease area not covered by the 1 m LiDAR data.

4.2.2 Boundary conditions

Design discharge hydrographs estimated using the new URBS hydrologic models were applied at the inflow boundary locations for the range of design events. Figure 4.1 and Figure 4.2 show the location of inflow and outflow boundaries in the BWC and SRC TUFLOW models, respectively. The inflow boundaries included in the models are as follows:

- BWC:
  - Fourteen (14) total inflow boundaries representing the inflows from the URBS subcatchments outside the hydraulic model boundary;
  - Fifteen (15) local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - one (1) ‘stage-discharge’ (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 0.13%;

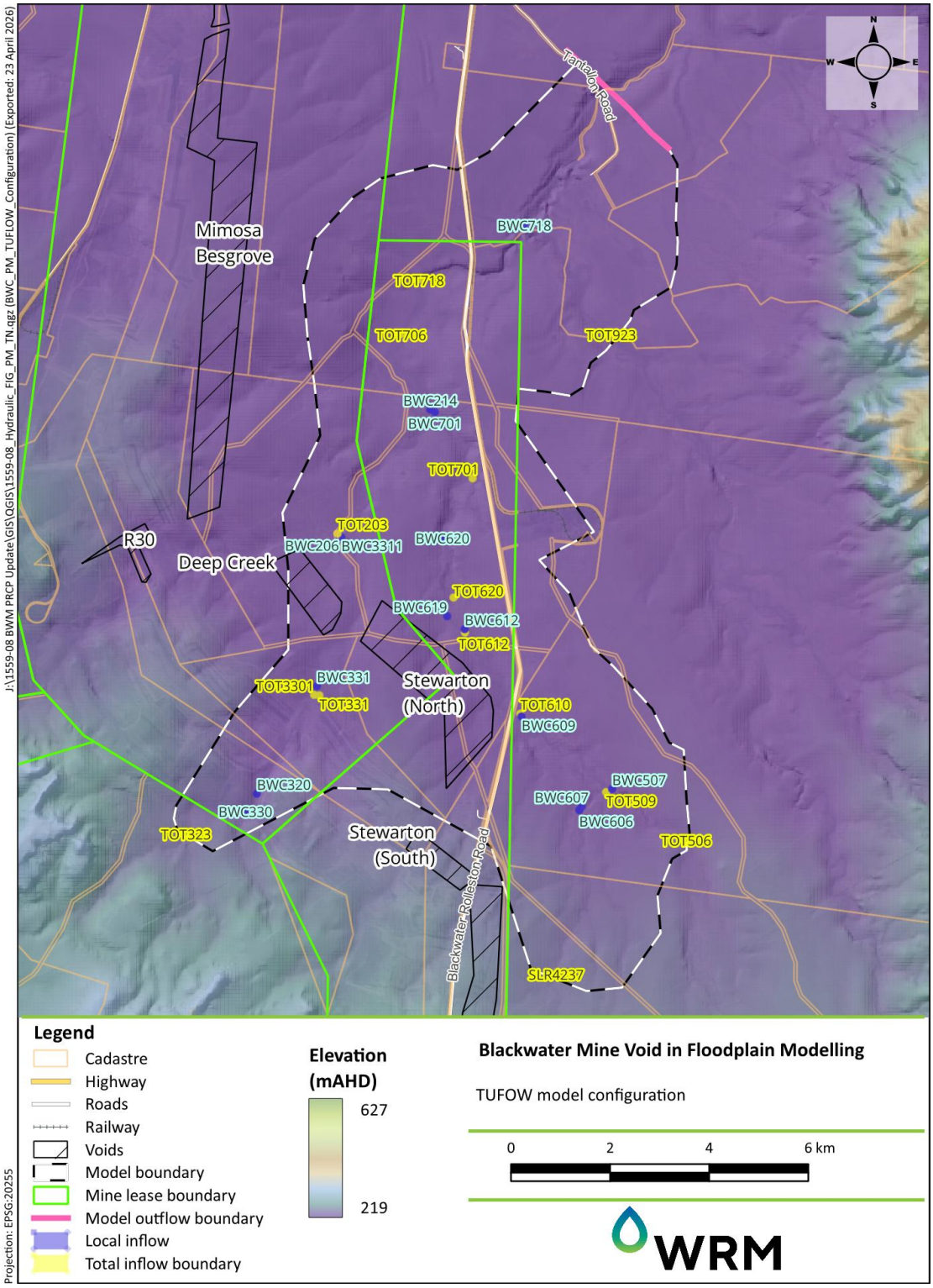


Figure 4.1 Blackwater Creek TUFLOW model configuration

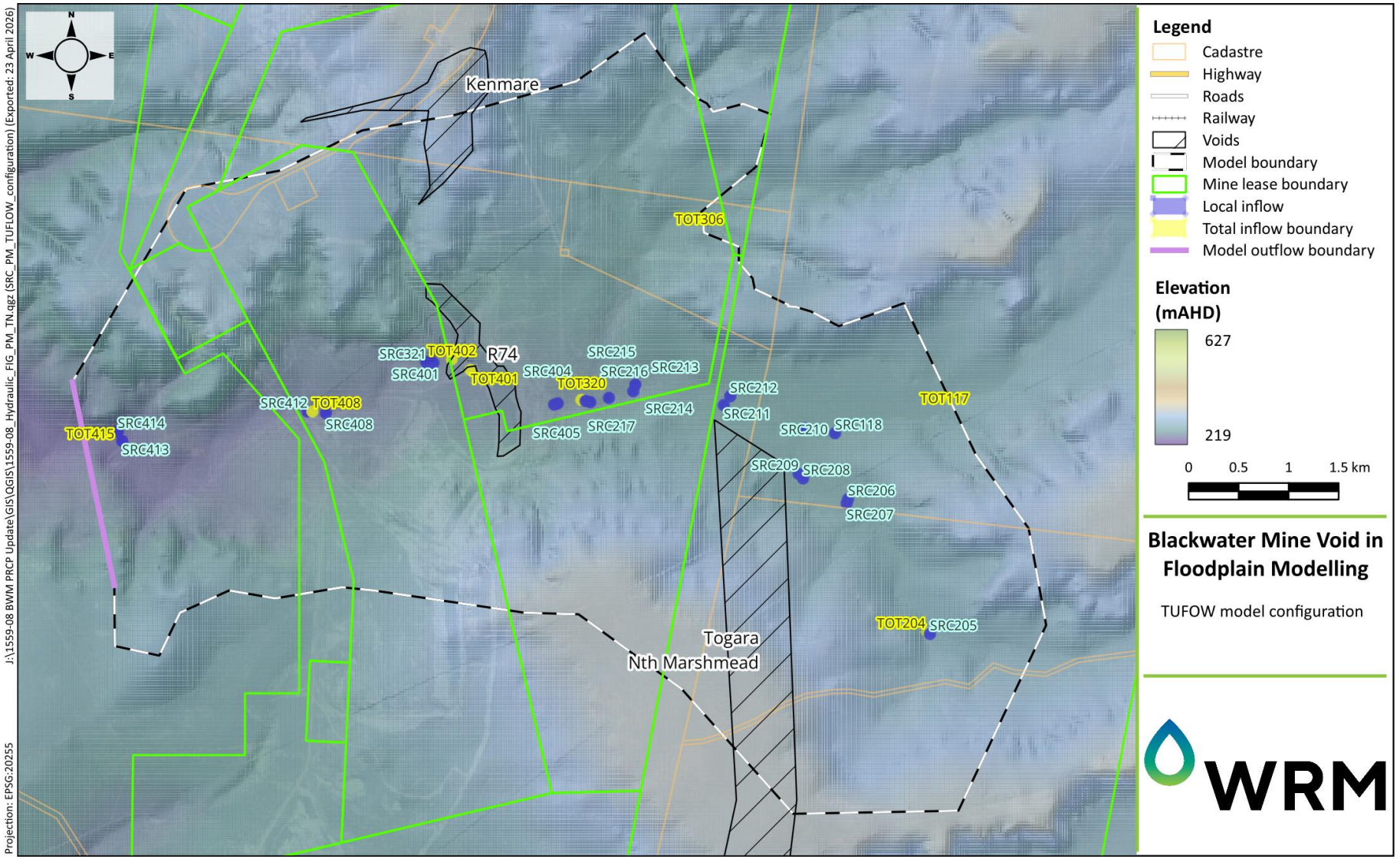


Figure 4.2 Sirius Creek model TUFLOW model configuration

- SRC:
  - Eight (8) total inflow boundaries representing the inflows from the URBS subcatchments outside the hydraulic model boundary;
  - Twenty-two (22) local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - one (1) 'stage-discharge' (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 0.53%.

4.2.3 Hydraulic resistance

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance (notionally channel or floodplain roughness. Discrete regions of continuous vegetation types and land uses were mapped, and appropriate roughness values assigned to each region. Vegetation and land use mapping was undertaken using an aerial photograph. Table 4.1 shows the adopted Manning's 'n' values adopted in the hydraulic model. The adopted Manning's n values for each land use type were unchanged from those adopted in the SLR (2024) studies.

Table 4.1 Adopted hydraulic roughness coefficients

Location	Adopted Manning's 'n'
Short grass	0.04
Sparse trees	0.06
Dense trees	0.08
Creeks	0.05
Water surface	0.02
Paved Roads	0.02

5 HYDRAULIC MODELLING RESULTS

5.1 BLACKWATER CREEK CATCHMENT

Figure 5.1 and Figure 5.2 show the predicted peak flood extents, levels, depths, and velocities along Taurus Creek, Two Mile Gully and Blackwater Creek. The model results are sumarised below.

The Deep Creek void is located partially within the Taurus Creek inundation extent for a 0.1% AEP flood event. Therefore, it is partially situated within a floodplain as defined by DETSI (2024). The final landform will be designed to prevent the ingress of floodwater into the Deep Creek void for all events up to and including a 0.1% AEP flood event at minimum.

The Stewarton North and Stewarton South voids are located outside of the Taurus Creek and Two Mile Gully inundation extents for a 0.1% AEP flood event. Therefore, these voids are not situated within a floodplain as defined by DETSI (2024).

5.2 SIRIUS CREEK CATCHMENT

Figure 5.3 and Figure 5.4 show the predicted peak flood extents, levels, depths, and velocities along Sirius Creek. The model results are sumarised below.

The Kenmare and Togara North Marshmead voids are located outside of the Sirius Creek inundation extent for a 0.1% AEP flood event. Therefore, these voids are not situated within a floodplain as defined by DETSI (2024).

The R74 void is situated across the Sirius Creek inundation extent for the 0.1% AEP flood event.

- Under current (operational) conditions, there is currently a licensed diversion for Sirius Creek (authorisation reference 52652F) that diverts Sirius Creek around the existing R74 open cut pit. The R74 pit is proposed to remain under post-mining conditions as the R74 void, as shown in Figure 5.3 and Figure 5.4.
- To maintain free drainage of the Sirius Creek catchment under post-mining conditions, a permanent diversion of Sirius Creek is required, to be developed in accordance with the watercourse diversion guideline (DNRME, 2019).

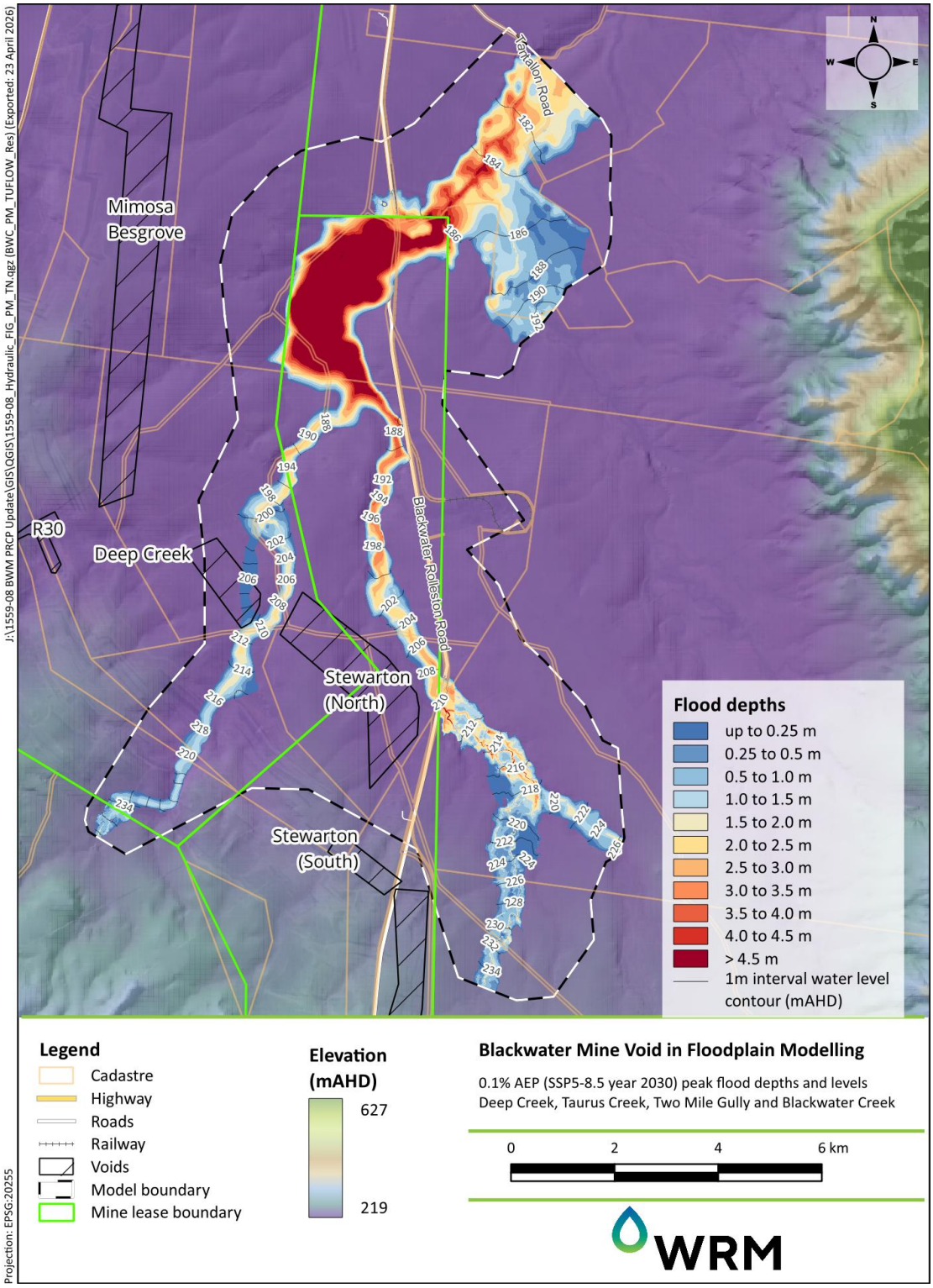


Figure 5.1 Peak flood depths and levels for 0.1% AEP event, Blackwater Creek

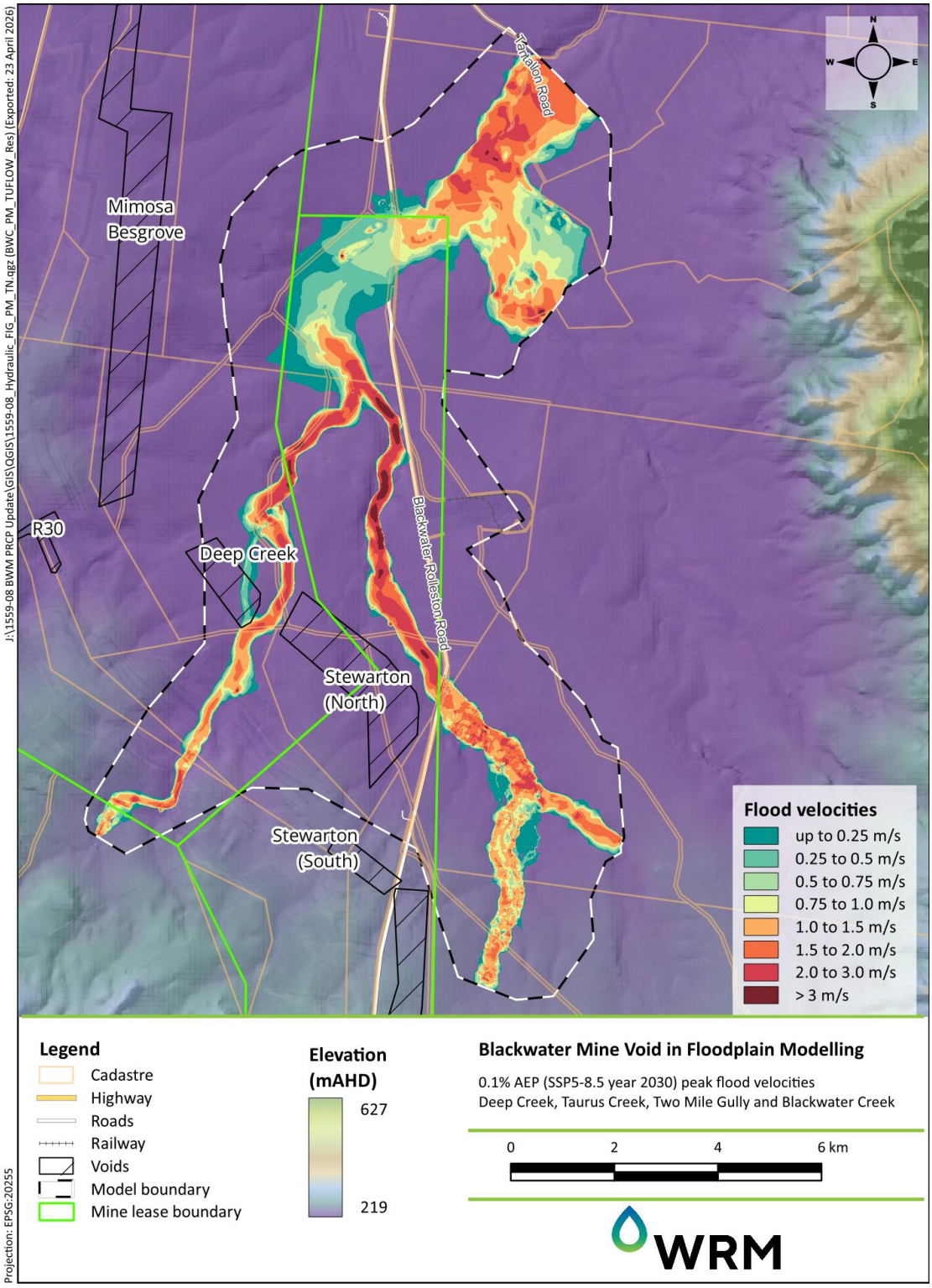


Figure 5.2 Peak flood velocities for 0.1 %AEP event, Blackwater Creek

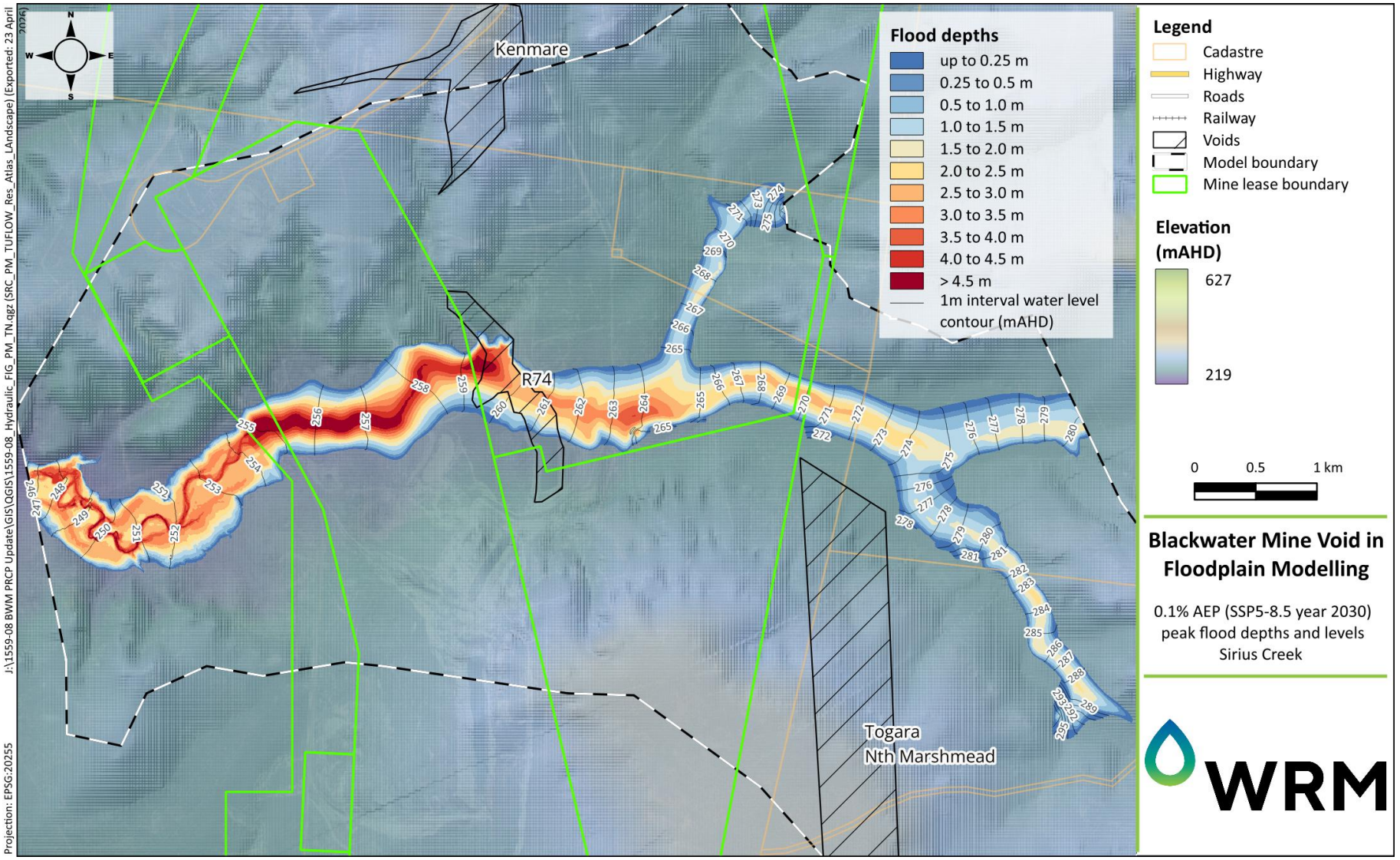


Figure 5.3 Peak flood depths and levels for 0.1 %AEP, Sirius Creek

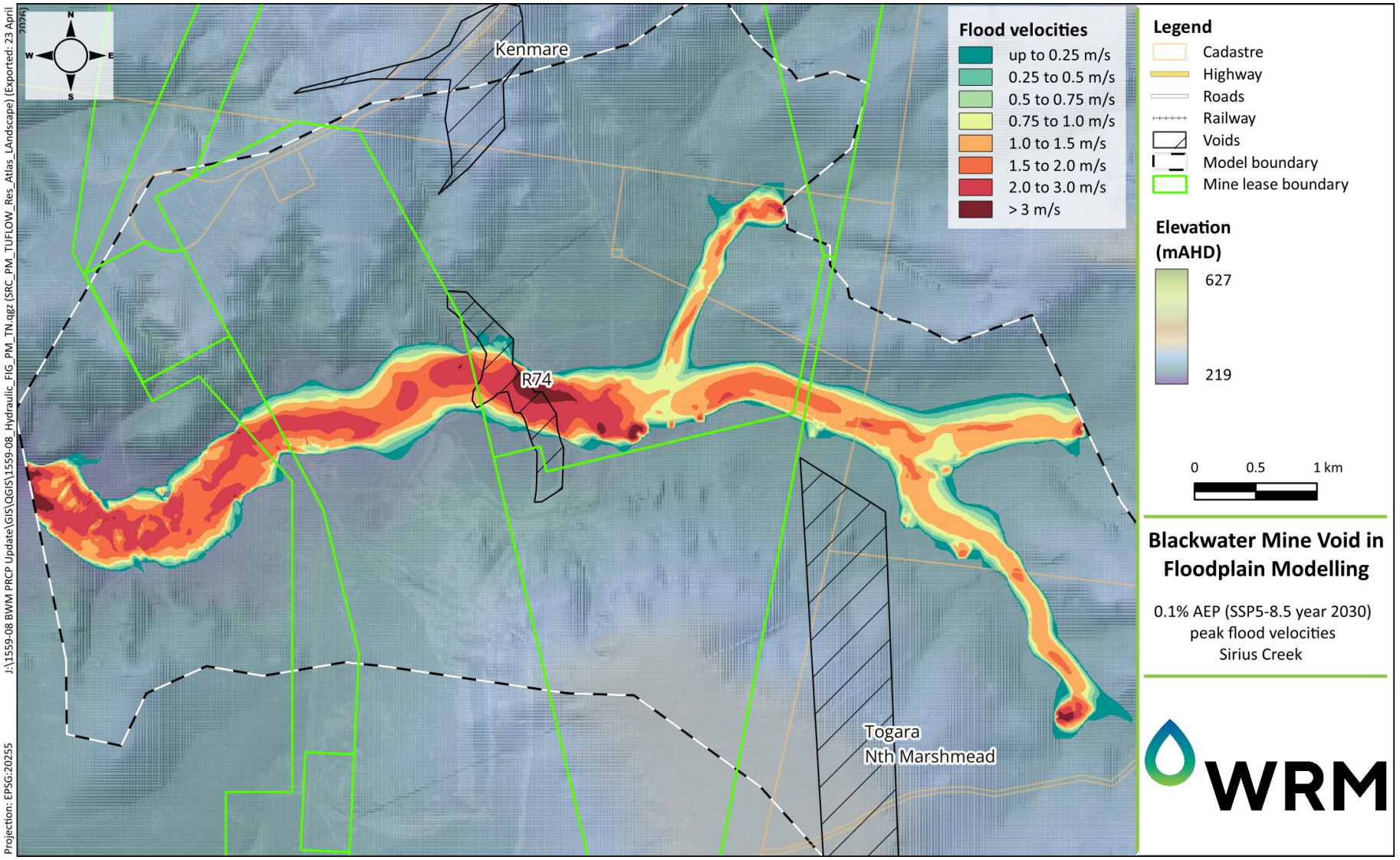


Figure 5.4 Peak flood velocities for 0.1 %AEP, Sirius Creek

6 SUMMARY OF FINDINGS

6.1 OVERVIEW

Hydrologic and hydraulic modelling of pre-mining conditions at BWM was undertaken to define the floodplain as defined in the PRCP guideline (DETSI, 2024), to supplement the BWM PRCP. As part of the PRCP for BWM, it is proposed to incorporate 15 final voids as Non-use Management Areas (NUMAs).

The following watercourses are of Strahler stream order 4 or greater and are therefore considered as relevant watercourses for the purpose of this study:

- Blackwater Creek;
- Two Mile Gully;
- Taurus Creek (downstream of the Emu Creek confluence); and
- Sirius Creek.

6.2 HYDROLOGIC AND HYDRAULIC MODEL DEVELOPMENT

Hydrologic and hydraulic modelling was undertaken to assess flood behaviour under pre-mining conditions along Taurus Creek, Two Mile Gully, Blackwater Creek and Sirius Creek.

New URBS hydrologic models were developed and calibrated to recorded data for the April 2017 and January 2020 flood events where data was available. Design event hydrologic modelling was undertaken in accordance with ARR 2019, for the 0.1% AEP design flood event. The new URBS models incorporate the latest climate change guidance from Australian Rainfall and Runoff 2019 Version 4.2 (ARR 2019 v4.2) (Ball et al, 2019). Design flood discharges were estimated based on the SSP5-8.5 (year 2030) climate scenario.

TUFLOW hydraulic models for the Blackwater Creek and Sirius Creek catchments previously developed by SLR (2024a and 2024b) were updated to incorporate new design discharge from the new URBS hydrologic models. The updated hydraulic models were used to estimate flood levels, depths, extents and velocities for 0.1% AEP design event.

6.3 VOIDS WITHIN THE FLOODPLAIN

The Deep Creek void is located partially within the Taurus Creek inundation extent for a 0.1% AEP flood event. Therefore, it is partially situated within a floodplain as defined by DETSI (2024). The final landform will be designed to prevent the ingress of floodwater into the Deep Creek void for all events up to and including a 0.1% AEP flood event at minimum.

The Stewarton North and Stewarton South voids are located outside of the Taurus Creek and Two Mile Gully inundation extents for a 0.1% AEP flood event. Therefore, these voids are not situated within a floodplain as defined by DETSI (2024).

The Kenmare and Togara North Marshmead voids are located outside of the Sirius Creek inundation extent for a 0.1% AEP flood event. Therefore, these voids are not situated within a floodplain as defined by DETSI (2024).

The R74 void is situated across the Sirius Creek inundation extent for the 0.1% AEP flood event.

- Under current (operational) conditions, there is currently a licensed diversion for Sirius Creek (authorisation reference 52652F) that diverts Sirius Creek around the existing R74 open cut pit. The R74 pit is proposed to remain under post-mining conditions as the R74 void, as shown in Figure 5.1 and Figure 5.2.

- To maintain free drainage of the Sirius Creek catchment under post-mining conditions, a permanent diversion of Sirius Creek is required, to be developed in accordance with the watercourse diversion guideline (DNRME, 2019).

7 REFERENCES

Ball et al., 2019	Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, 2019, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia (Geoscience Australia), Version 4.2.
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SLR, 2024b	SLR Consulting Australia, October 2024, *Blackwater Mine – Progressive Rehabilitation and Closure Plan – Voids in Floodplain Modelling*.

APPENDIX A URBS MODEL CONFIGURATION

A.1 BWC CATCHMENT

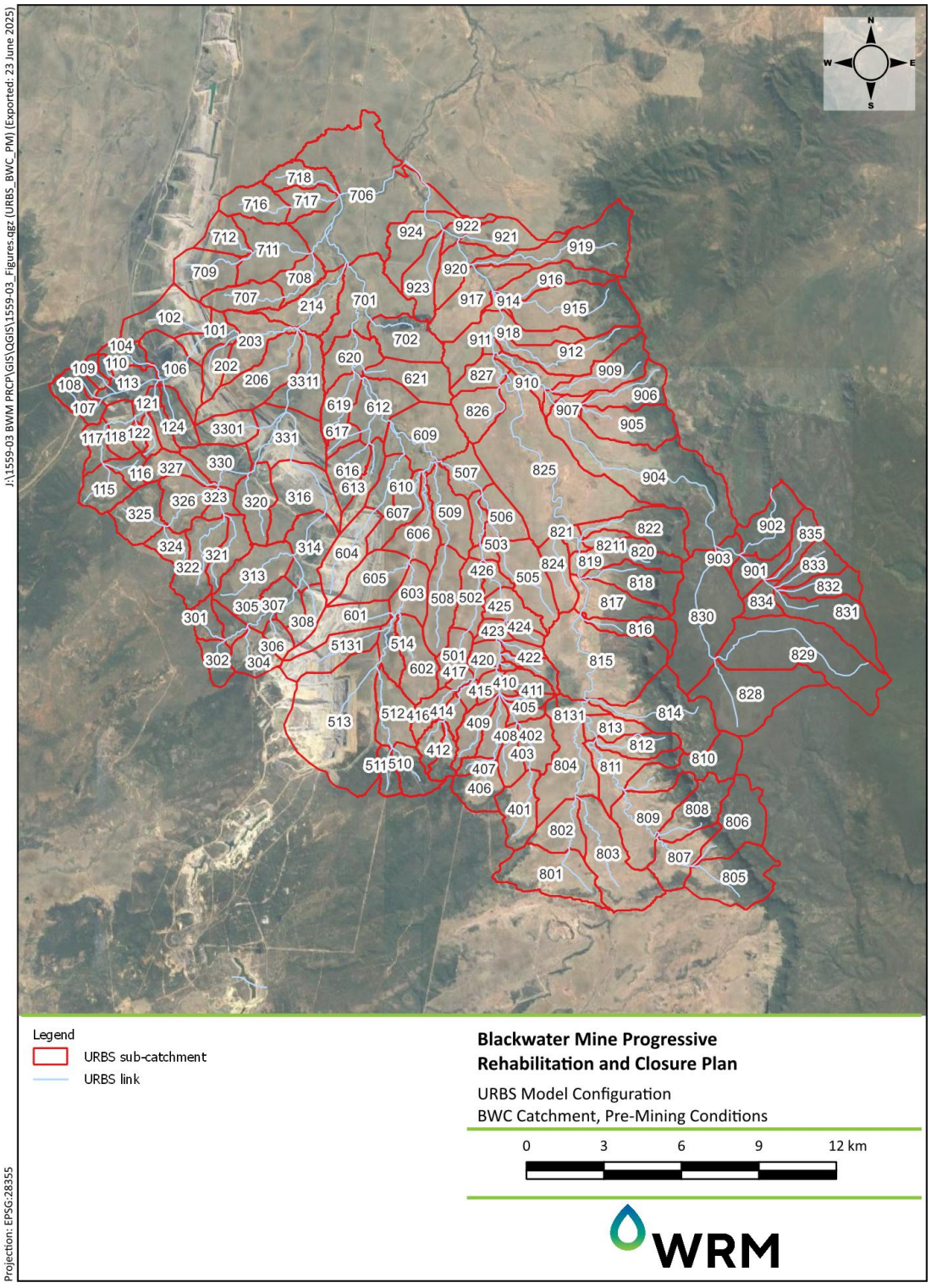


Figure A.1 URBS model configuration of the BWC catchment, pre-mining conditions

Table A.1 URBS subcatchment parameters, Blackwater Creek catchment, pre-minging conditions

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	2.24	0	0.07	0.007
102	4.38	0	0.07	0.016
104	1.37	0	0.07	0.031
106	4.24	0	0.07	0.014
107	2.03	0	0.07	0.031
108	0.80	0	0.07	0.053
109	0.73	0	0.07	0.045
110	0.36	0	0.07	0.050
113	2.61	0	0.07	0.010
115	2.55	0	0.07	0.017
116	1.21	0	0.07	0.007
117	1.58	0	0.07	0.014
118	2.19	0	0.07	0.021
120	0.49	0	0.07	0.042
121	0.88	0	0.07	0.007
122	0.79	0	0.07	0.029
123	1.05	0	0.07	0.023
124	1.96	0	0.07	0.014
202	1.61	0	0.07	0.012
203	3.80	0	0.07	0.008
206	5.86	0	0.07	0.010
214	4.02	0	0.07	0.006
301	1.38	0	0.07	0.027
302	1.68	0	0.07	0.020
303	1.14	0	0.07	0.024
304	2.49	0	0.07	0.028
305	1.24	0	0.07	0.010
306	1.16	0	0.07	0.022
307	1.90	0	0.07	0.028
308	1.83	0	0.07	0.019
313	4.87	0	0.07	0.017
314	4.14	0	0.07	0.006
316	5.68	0	0.07	0.012

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
320	3.47	0	0.07	0.017
321	2.47	0	0.07	0.020
322	4.10	0	0.07	0.017
323	1.07	0	0.07	0.019
324	1.70	0	0.07	0.025
325	3.44	0	0.07	0.023
326	3.48	0	0.07	0.017
327	2.11	0	0.07	0.017
330	3.25	0	0.07	0.010
3301	2.55	0	0.07	0.016
331	5.73	0	0.07	0.009
3311	3.96	0	0.07	0.006
401	3.40	0	0.07	0.015
402	2.59	0	0.07	0.012
403	1.73	0	0.07	0.014
404	0.92	0	0.07	0.011
405	0.74	0	0.07	0.027
406	2.67	0	0.07	0.025
407	0.62	0	0.07	0.043
408	1.72	0	0.07	0.014
409	2.13	0	0.07	0.019
410	1.21	0	0.07	0.003
411	1.35	0	0.07	0.030
412	1.33	0	0.07	0.028
413	1.28	0	0.07	0.030
414	0.97	0	0.07	0.015
415	0.66	0	0.07	0.017
416	1.65	0	0.07	0.014
417	0.55	0	0.07	0.009
418	0.57	0	0.07	0.009
419	0.21	0	0.07	0.011
420	1.00	0	0.07	0.009
421	1.25	0	0.07	0.030
422	0.87	0	0.07	0.014
423	1.00	0	0.07	0.009

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
424	0.79	0	0.07	0.014
425	2.31	0	0.07	0.008
426	1.00	0	0.07	0.004
501	2.03	0	0.07	0.011
502	2.62	0	0.07	0.007
503	0.64	0	0.07	0.002
504	1.03	0	0.07	0.006
505	4.68	0	0.07	0.007
506	2.69	0	0.07	0.005
507	2.41	0	0.07	0.006
508	4.43	0	0.07	0.005
509	3.89	0	0.07	0.006
510	2.33	0	0.07	0.031
511	1.25	0	0.07	0.035
512	3.45	0	0.07	0.016
513	14.59	0	0.07	0.013
5131	3.58	0	0.07	0.017
514	1.71	0	0.07	0.006
601	3.60	0	0.07	0.014
602	3.88	0	0.07	0.008
603	2.51	0	0.07	0.006
604	4.00	0	0.07	0.009
605	4.01	0	0.07	0.013
606	3.28	0	0.07	0.006
607	2.83	0	0.07	0.007
609	6.13	0	0.07	0.004
610	2.30	0	0.07	0.010
612	4.10	0	0.07	0.005
613	1.98	0	0.07	0.010
616	2.86	0	0.07	0.010
617	0.85	0	0.07	0.012
619	2.57	0	0.07	0.010
620	3.14	0	0.07	0.010
621	3.66	0	0.07	0.009
701	6.45	0	0.07	0.006

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
702	4.00	0	0.07	0.008
706	18.48	0	0.07	0.005
707	2.88	0	0.07	0.009
708	2.14	0	0.07	0.009
709	3.84	0	0.07	0.013
711	4.99	0	0.07	0.010
712	2.18	0	0.07	0.016
716	2.95	0	0.07	0.011
717	2.06	0	0.07	0.013
718	2.25	0	0.07	0.014
801	6.08	0	0.07	0.014
802	3.02	0	0.07	0.016
803	7.28	0	0.07	0.011
804	6.33	0	0.07	0.010
805	5.87	0	0.07	0.054
806	4.86	0	0.07	0.093
807	3.45	0	0.07	0.017
808	3.68	0	0.07	0.093
809	5.80	0	0.07	0.040
810	4.62	0	0.07	0.087
811	3.55	0	0.07	0.010
812	2.30	0	0.07	0.048
813	1.91	0	0.07	0.027
8131	1.06	0	0.07	0.020
814	7.10	0	0.07	0.079
815	11.57	0	0.07	0.037
816	2.31	0	0.07	0.102
817	3.79	0	0.07	0.067
818	3.83	0	0.07	0.066
819	0.56	0	0.07	0.013
820	3.15	0	0.07	0.056
821	0.75	0	0.07	0.000
8211	0.76	0	0.07	0.025
822	4.47	0	0.07	0.064
824	2.73	0	0.07	0.006

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
825	18.60	0	0.07	0.005
826	2.96	0	0.07	0.006
827	2.01	0	0.07	0.010
828	8.08	0	0.07	0.013
829	12.06	0	0.07	0.015
830	10.24	0	0.07	0.014
831	4.87	0	0.07	0.026
832	2.36	0	0.07	0.035
833	2.38	0	0.07	0.034
834	1.62	0	0.07	0.029
835	2.01	0	0.07	0.041
901	2.16	0	0.07	0.029
902	4.27	0	0.07	0.029
903	0.86	0	0.07	0.042
904	15.68	0	0.07	0.030
905	4.65	0	0.07	0.035
906	3.15	0	0.07	0.032
907	0.56	0	0.07	0.006
908	0.42	0	0.07	0.007
909	3.92	0	0.07	0.021
910	2.02	0	0.07	0.005
911	0.34	0	0.07	0.014
912	4.87	0	0.07	0.019
914	0.39	0	0.07	0.004
915	8.00	0	0.07	0.022
916	3.12	0	0.07	0.034
917	5.05	0	0.07	0.007
918	5.11	0	0.07	0.008
919	7.07	0	0.07	0.025
920	2.75	0	0.07	0.010
921	3.07	0	0.07	0.011
922	0.80	0	0.07	0.007
923	3.09	0	0.07	0.009
924	4.33	0	0.07	0.007

A.2 SRC CATCHMENT

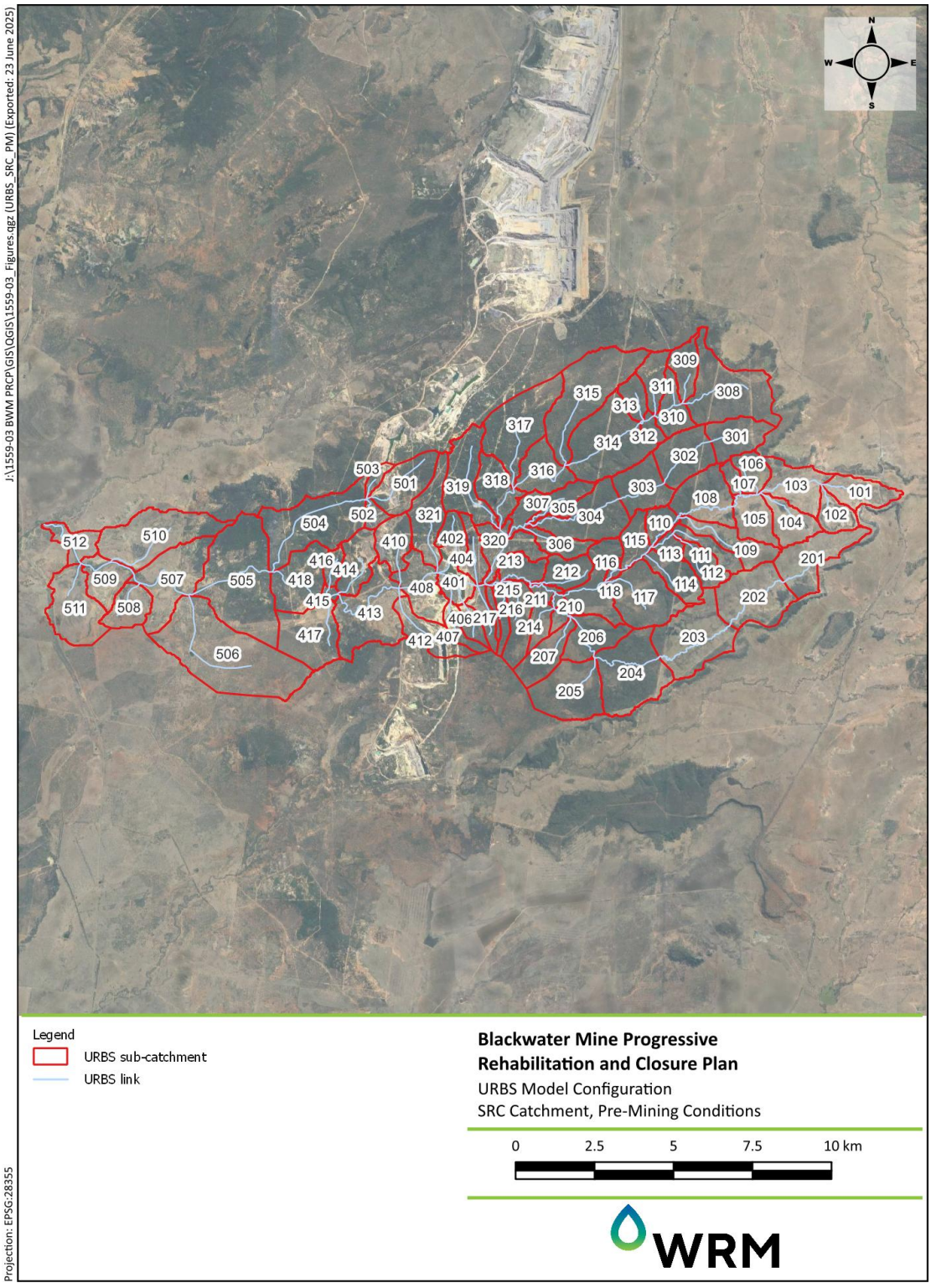


Figure A.2 URBS model configuration of the SRC catchment, pre-mining conditions

Table A.2 URBS subcatchment parameters, Sirius Creek catchment, pre-minging conditions

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.70	0	0.045	0.02
102	1.18	0	0.045	0.02
103	2.37	0	0.045	0.02
104	1.66	0	0.045	0.03
105	1.75	0	0.045	0.03
106	1.13	0	0.045	0.03
107	0.48	0	0.045	0.05
108	2.73	0	0.045	0.02
109	1.92	0	0.045	0.02
110	0.88	0	0.045	0.01
111	1.09	0	0.045	0.02
112	1.22	0	0.045	0.03
113	0.56	0	0.045	0.02
114	1.67	0	0.045	0.03
115	1.20	0	0.045	0.01
116	0.22	0	0.045	0.01
117	3.37	0	0.045	0.03
118	2.53	0	0.045	0.02
201	2.99	0	0.045	0.01
202	3.68	0	0.045	0.01
203	4.37	0	0.045	0.02
204	4.50	0	0.045	0.01
205	3.48	0	0.045	0.02
206	2.04	0	0.045	0.015
207	1.76	0	0.045	0.017
208	0.48	0	0.045	0.016
209	0.87	0	0.045	0.027
210	0.21	0	0.045	0.028
211	0.40	0	0.045	0.033
212	1.40	0	0.045	0.045
213	1.11	0	0.045	0.018
214	1.95	0	0.045	0.021
215	0.13	0	0.045	0.010
216	0.66	0	0.045	0.023

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
217	0.30	0	0.045	0.030
301	2.02	0	0.045	0.015
302	2.56	0	0.045	0.028
303	2.28	0	0.045	0.009
304	3.30	0	0.045	0.009
305	1.21	0	0.045	0.025
306	1.09	0	0.045	0.016
307	0.88	0	0.045	0.011
308	4.70	0	0.045	0.013
309	1.31	0	0.045	0.015
310	1.43	0	0.045	0.012
311	1.27	0	0.045	0.019
312	0.45	0	0.045	0.021
313	0.94	0	0.045	0.027
314	4.85	0	0.045	0.037
315	5.08	0	0.045	0.033
316	2.05	0	0.045	0.008
317	4.24	0	0.045	0.005
318	1.95	0	0.045	0.008
319	3.07	0	0.045	0.005
320	1.98	0	0.045	0.024
321	2.50	0	0.045	0.014
401	1.62	0	0.045	0.041
402	0.75	0	0.045	0.046
404	1.17	0	0.045	0.021
405	0.92	0	0.045	0.012
406	0.72	0	0.045	0.022
407	0.80	0	0.045	0.014
408	2.31	0	0.045	0.015
410	1.64	0	0.045	0.020
412	1.92	0	0.045	0.011
413	4.31	0	0.045	0.011
414	1.87	0	0.045	0.025
415	0.22	0	0.045	0.017
416	0.59	0	0.045	0.028

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
417	3.22	0	0.045	0.048
418	2.88	0	0.045	0.029
501	2.47	0	0.045	0.014
502	0.51	0	0.045	0.017
503	0.45	0	0.045	0.016
504	5.25	0	0.045	0.016
505	7.12	0	0.045	0.013
506	8.51	0	0.045	0.015
507	3.87	0	0.045	0.009
508	1.58	0	0.045	0.024
509	1.75	0	0.045	0.006
510	4.53	0	0.045	0.034
511	3.34	0	0.045	0.010
512	1.25	0	0.045	0.046

APPENDIX B HYDROLOGIC MODEL DEVELOPMENT, CALIBRATION AND VALIDATION REPORT

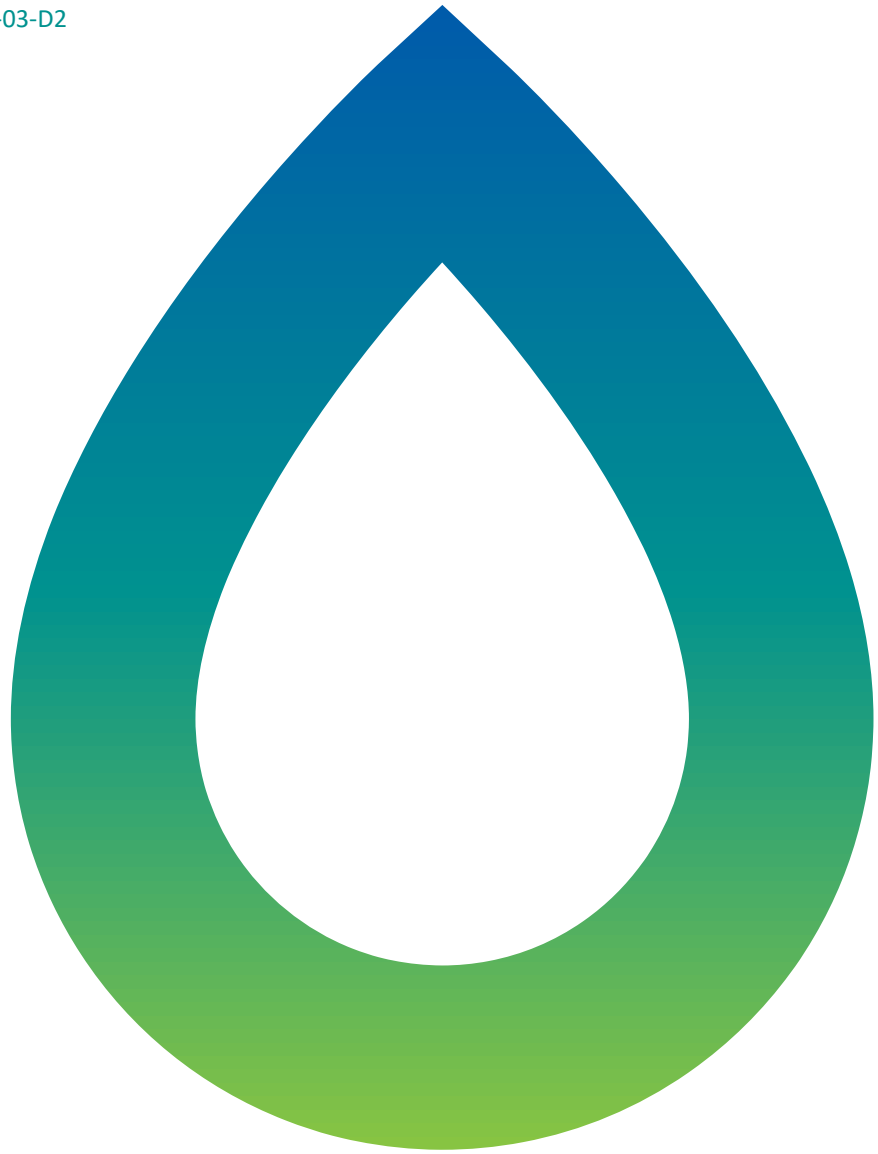
BLACKWATER MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN

Hydrologic Model Development, Calibration and Validation Report

Whitehaven Coal Limited

28 November 2025

1559-03-D2



DETAILS

Report Title	BLACKWATER MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN, Hydrologic Model Development, Calibration and Validation Report
Client	Whitehaven Coal Limited

THIS REVISION

Report Number	1559-03-D2
Date	28 November 2025
Author	Lorena Miranda
Reviewer	Ardianto Notodirdjo

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1 INTRODUCTION

1.1 OVERVIEW

Whitehaven, the owners of Blackwater Mine (BWM), has requested WRM Water & Environment Pty Ltd (WRM) to undertake hydrologic and hydraulic modelling for the BWM Progressive Rehabilitation and Closure Plan (PRCP) for Revision 2 (Rev 2) of the BWM final landform configuration.

New hydrologic models were developed using the URBS software package, which incorporates the latest climate change guidance from Australian Rainfall and Runoff 2019 Version 4.2 (ARR 2019 v4.2) (Ball et al, 2019). Additionally, URBS has increasingly become the industry standard (and preferred) software package for undertaking hydrologic modelling.

This "hydrologic model development report" presents the development, calibration and validation of seven (7) URBS hydrologic models for the catchments that drain across BWM. The modelled catchments are listed below and shown on Figure 1.1:

- Bonnie Doon Creek;
- Sagittarius Creek;
- Burngrove Creek;
- Blackwater Creek (including Deep Creek, Emu Creek, Taurus Creek and Two Mile Gully);
- Speculation Creek;
- Sirius Creek; and
- Rockland Creek.

This report provides the foundation for the following two flood assessments that inform the PRCP for Rev 2 of the BWM final landform:

- The Void in Floodplain Modelling assessment (WRM, 2025a); and
- The Final Landform Flood Modelling Assessment (WRM, 2025b).

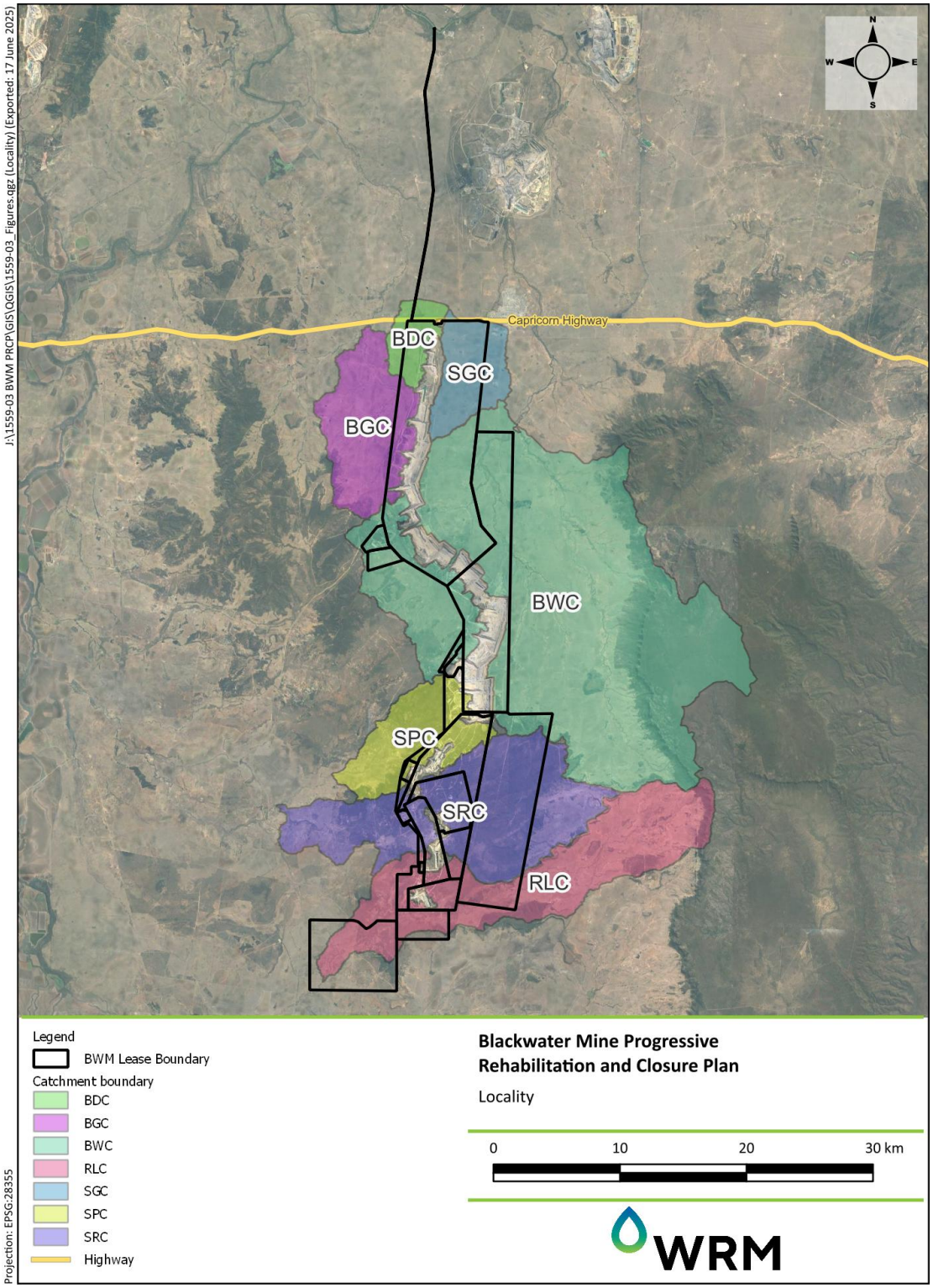


Figure 1.1 Study site locality

1.2 SCOPE OF STUDY

The proposed scope of works for this study included the following tasks:

- Development of a hydrologic model of the Burngrove Creek (BGC) catchment and calibration of the model using recorded water level data at the Burngrove Creek Upstream stream gauge (station 330127);
- Development of a hydrologic model of the Blackwater Creek (BWC) catchment and calibration of the model using recorded water level data at the Taurus Creek Downstream stream gauge (station 330101) and at the Two Mile Gully stream gauge (station 330124);
- Development of a hydrologic model of the Speculation Creek (SPC) catchment and calibration of the model using recorded water level data at the Speculation Creek stream gauge (station 330126);
- Development a hydrologic model of the Sirius Creek (SRC) catchment and calibration of the model using recorded water level data at the Sirius Creek Downstream stream gauge (station 330118), followed by validation of the model predicted 1% (1 in 100) annual exceedance probability (AEP) design discharges against discharge estimates from empirical methods.
- Development of hydrologic models of the Bonnie Doon Creek, Sagittarius Creek and Rockland Creek catchments and validation of the model predicted 1% AEP design discharges against discharge estimates from empirical methods.

1.3 REPORT STRUCTURE

The report is structured as follows:

- Section 2 is an overview of the data available for this study;
- Section 3 describes the development of the hydrologic model;
- Section 4 presents the hydrologic model calibration;
- Section 5 presents the hydrologic model validation;
- Section 6 is a list of references.

2 EXISTING DRAINAGE CHARACTERISTICS

Figure 2.1 shows the existing drainage characteristics in the vicinity of BWM, which are described as follows:

- Bonnie Doon Creek (BDC) drains in a northerly direction west of the BWM workings.
- Sagittarius Creek (SGC) drains in a northerly direction east of the BWM workings.
- The Burngrove Creek (BGC) catchment comprises the following three streams:
    - Burngrove Creek flows in a northeasterly direction west of the BWM workings. A 3 km section of the natural Burngrove Creek channel was removed by the BWM workings and replaced by a diversion channel that drains north between the railway and the BWM.
    - Cabbagetree Creek originates from the southwest of the catchment and drains in a northeasterly direction west of BWM before joining Burngrove Creek.
    - Tolmies Creek originates from the west of the catchment and drains in a northeasterly direction west of BWM before joining Burngrove Creek.
- The Blackwater Creek (BGC) catchment comprises the following five streams:
    - Blackwater Creek originates from the south of the catchment and flows in a northern direction. This creek does not interact with the BWM lease.
    - Taurus Creek, a major tributary of Blackwater Creek, originates from the east of BWM and drains in a northeasterly direction through BWM between the R38S and R42N open cut pits, eventually joining Blackwater Creek about 6 km east of BWM.
    - Deep Creek, a tributary of Taurus Creek, originates from the west of BWM and drains in a northeasterly direction through BWM via the temporary Deep Creek diversion between the R30S and R34S open cut pits, before joining Taurus Creek about 3 km east of BWM.
    - Two Mile Gully, a tributary of Taurus Creek, flows in a northerly direction east of BWM and joins Taurus Creek about 5 km east of BWM.
    - Emu Creek, a tributary of Taurus Creek, originates from the west (upstream) of BWM and flows in a northeasterly direction. It is then diverted in a northwesterly direction via the Emu Creek Diversion, which drains to Taurus Creek just upstream (west) of BWM.
- Speculation Creek (SPC) originates from the western extents of BWM and flows in a southwesterly direction away from BWM. The upper extents of the Speculation Creek catchment have been heavily disturbed by BWM mining operations.
- Sirius Creek originates from the east (upstream) of BWM. It flows in a westerly direction through BWM via the temporary Sirius Creek diversion between the R74 and R78N open cut pits. Downstream of the Sirius Creek Diversion, Sirius Creek continues to drain in a westerly direction away from BWM.
- Rockland Creek originates from the east (upstream) of the BWM. It flows in a westerly direction through BWM and south of the R82S open cut pit. Rockland Creek drains into Rockland Dam just upstream (east) of the mine.
    - Rockland Dam is formed by an earthen embankment across the Rockland Creek channel and floodplain. Rockland Dam is a free-draining structure, with a low-flow culvert outlet at the base of the dam and an overflow spillway weir and channel at the northern end of the dam.

- Table 2.1 shows the key characteristics of Rockland Dam obtained from the *Rockland Creek Diversion Construction Report* (PPK Consultants, 1994), the GHD (2021) report and the 2024 LiDAR data.

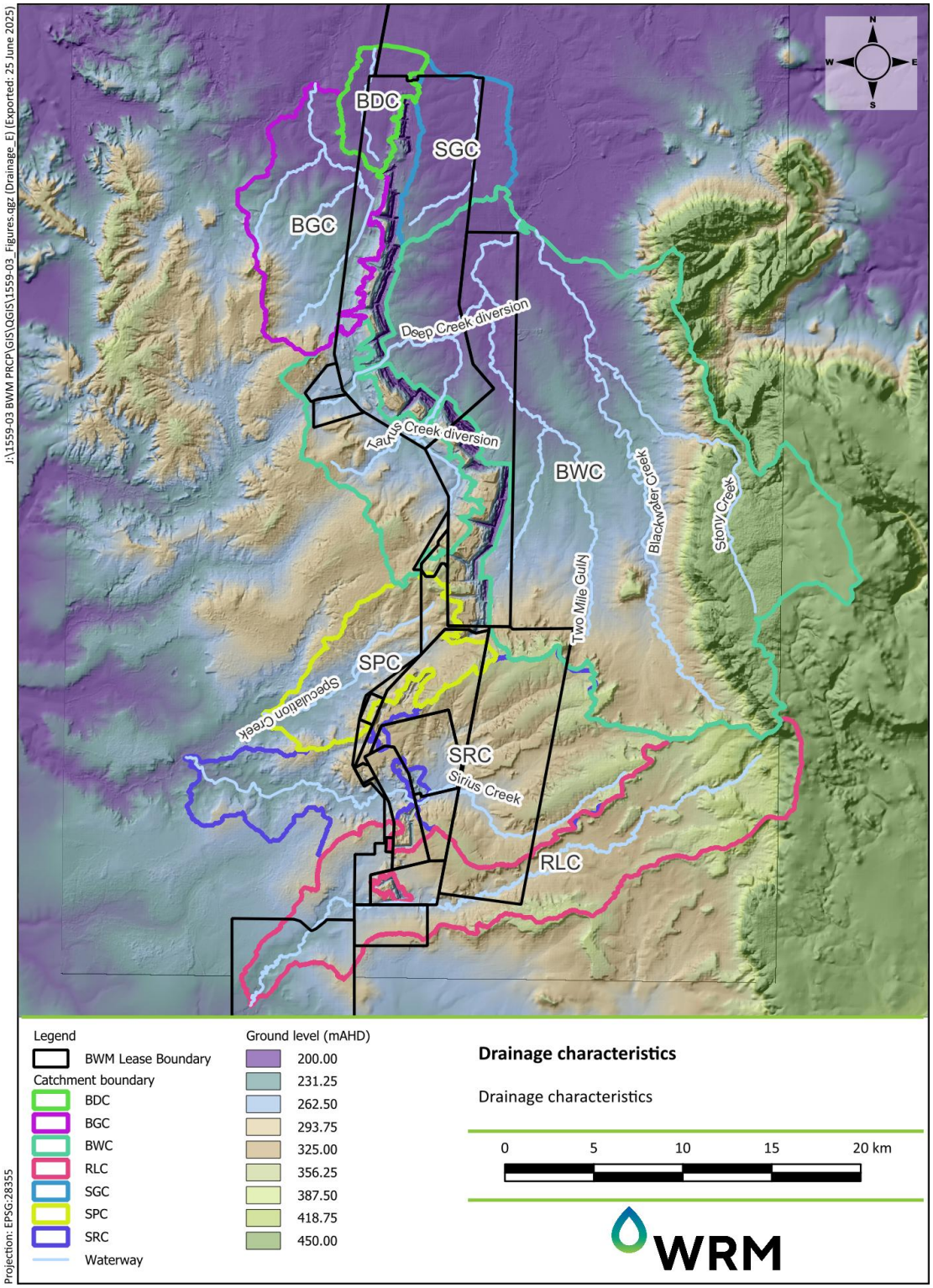


Figure 2.1 Study site drainage characteristics

- Figure 2.2 shows the stage-storage relationship for the dam derived from the LiDAR topographic data obtained in 2024. Figure 2.3 shows the stage-discharge relationship of the dam outlet derived from TUFLOW hydraulic model results.

Table 2.1 Rockland Dam key details

Dam feature	Value	Comment
Dam crest	281.2 mAHD	Based on 2024 LiDAR data
Dam crest width	8 m	Based on PPK (1994) construction report
Embankment height	16.1 m	Based on GHD (2021) report
Spillway invert	278.7 mAHD	Based on 2024 LiDAR data
Spillway width at crest	50 m	Based on GHD (2021) report
Outlet works	1.68 m wide and 1.95 m high box culverts Inlet invert = 263.4 mAHD Outlet invert = 262.8 mAHD	Based on GHD (2021) report
Storage volume at crest	20,310 ML	Based on PPK (1994) construction report

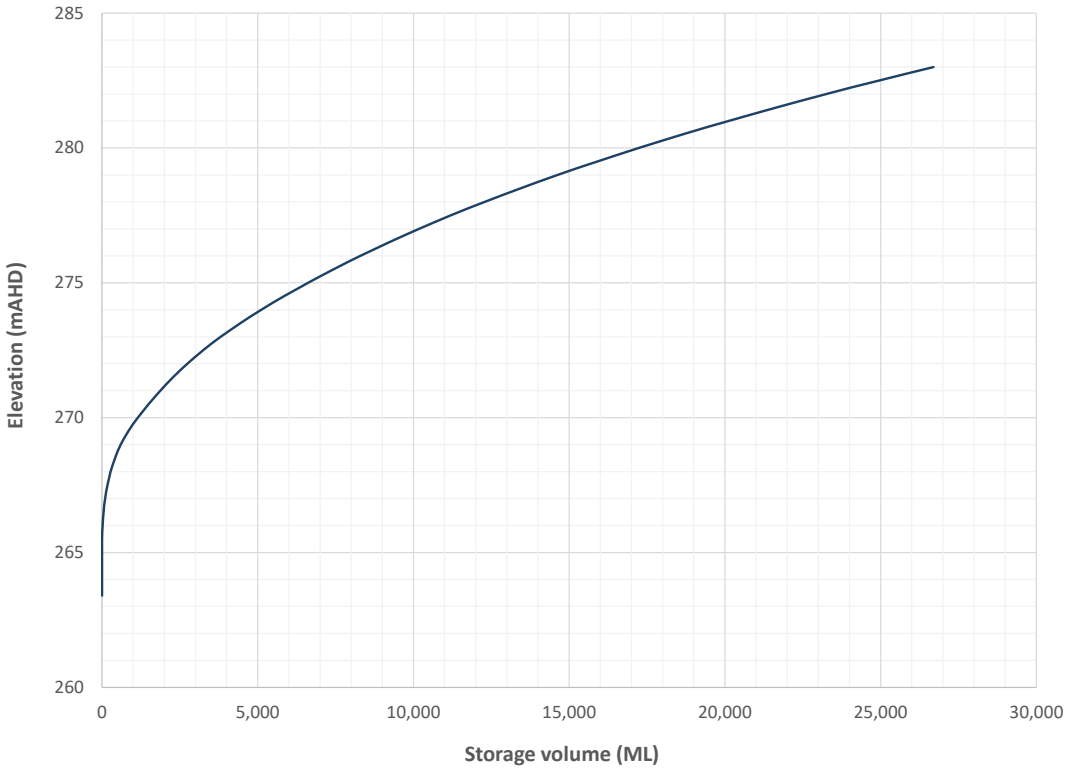


Figure 2.2 Stage-storage relationship for Rockland Dam

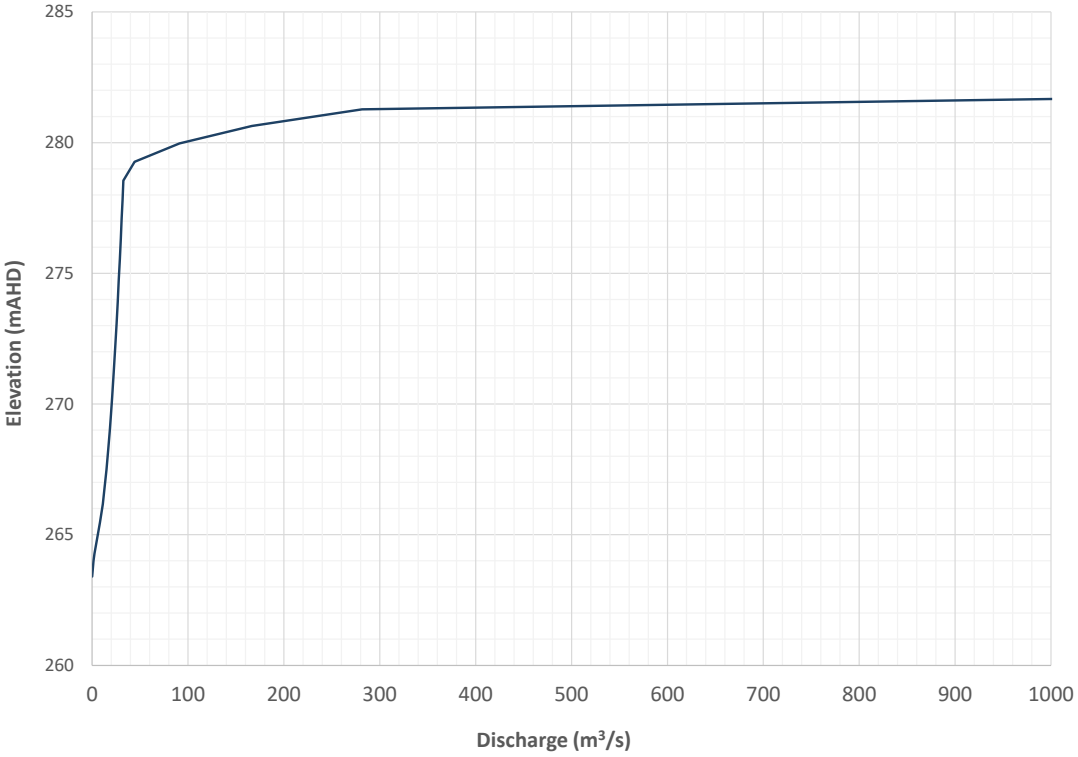


Figure 2.3 Stage-discharge relationship for the Rockland Dam outlet

3 AVAILABLE DATA

3.1 OVERVIEW

The following data was provided by Whitehaven for this study:

- Previous hydrologic and hydraulic studies;
- Recorded rainfall and water level data; and
- LiDAR topographic data.

3.2 PREVIOUS STUDIES

3.2.1 Blackwater Mine Flood Study (2021)

The Blackwater Mine Flood Study undertaken by GHD (2021) assessed existing flood risks across BWM. XP-RAFTS hydrologic and TUFLOW hydraulic models were developed for this study. In this study, the hydrologic models for Burngrove Creek and Speculation Creek were calibrated to recorded water level data. The GHD (2021) study report was provided for this study, but the XP-RAFTS and TUFLOW models were not available.

3.2.2 Blackwater Mine Progressive Rehabilitation and Closure Plan (2024)

The XP-RAFTS hydrologic and TUFLOW hydraulic models used by SLR (2024a and 2024b) for the Rev 1 PRCP flood assessment were provided for this study. These models appear to have been developed based on the GHD (2021) hydrologic and hydraulic models. Separate models were provided for the following catchments:

- Bonnie Doon Creek;
- Blackwater Creek;
- Burngrove Creek;
- Rockland Creek;
- Sagittarius Creek;
- Sirius Creek;
- Speculation Creek;
- Taurus Creek; and
- Two Mile Gully.

3.3 RAINFALL AND WATER LEVEL DATA

3.3.1 Rainfall and water level gauging stations

Figure 3.1 shows the location of three subdaily rainfall (pluviograph) stations and six stream gauging stations across BWM. Table 3.1 and Table 3.2 show details of these stations.

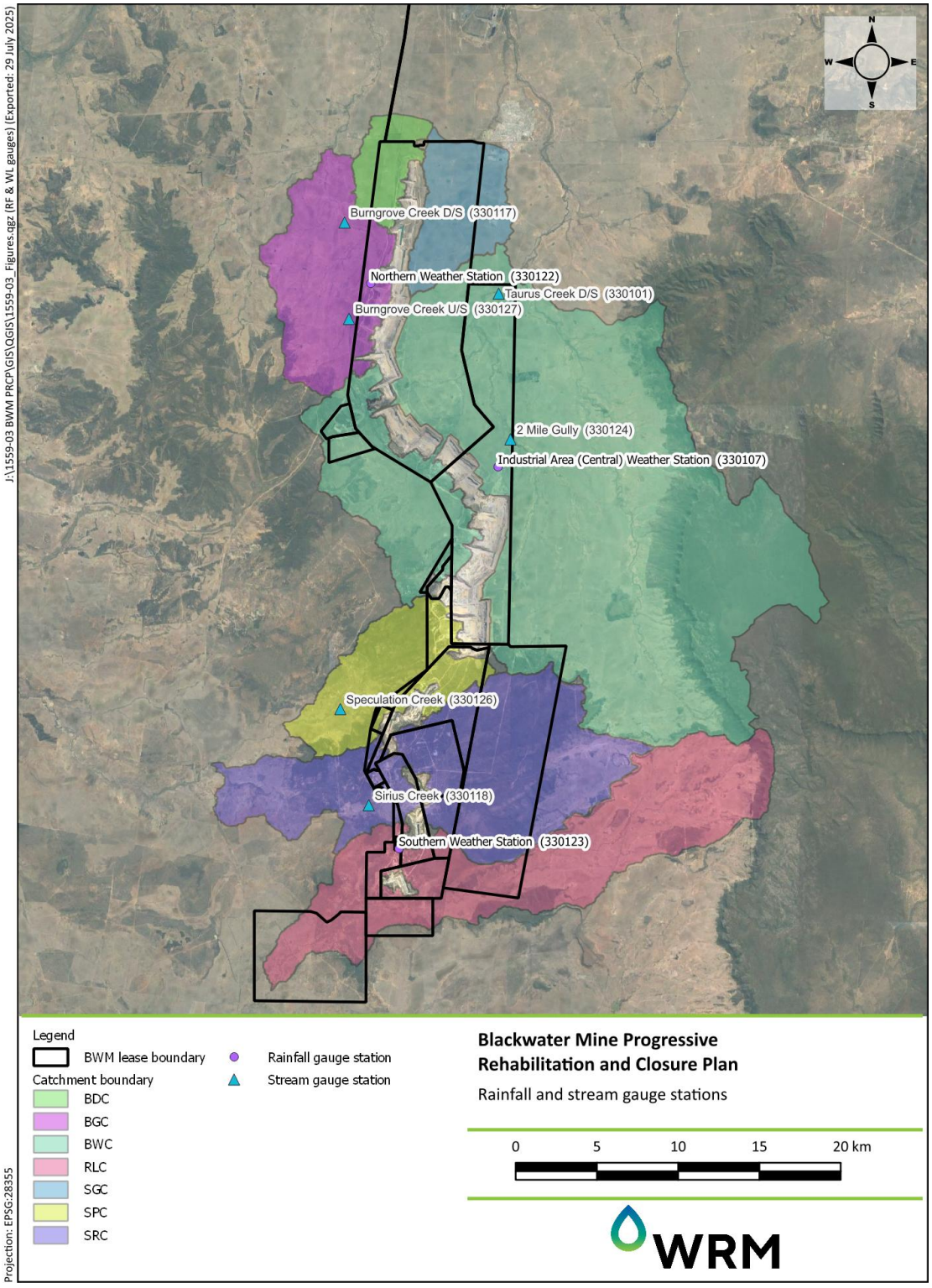


Figure 3.1 Location of rainfall and stream gauging stations

Table 3.1 Details of available subdaily rainfall (pluviograph) stations

Station Number	Station Name	Supplied data period
330122	Northern Weather Station	January 2016 – January 2025
330107	Industrial Areal (Central) Weather Station	January 2016 – January 2025
330123	Southern Weather Station	January 2016 – January 2025

Table 3.2 Details of available stream gauging stations

Station Number	Station Name	Supplied data period
330101	Taurus Creek D/S	January 2016 – January 2025
330118	Sirius Creek D/S	January 2016 – January 2025
330124	Two Mile Gully	January 2016 – January 2025
330126	Speculation Creek	January 2016 – January 2025
330127	Burngrove Creek U/S	January 2016 – January 2025
330117	Burngrove Creek D/S	January 2016 – January 2025

3.3.2 Rating curves

Whitehaven provided rating curves for the six gauges listed in Table 3.2 (referred to in this report as the Whitehaven rating curves). It was uncertain if the Whitehaven rating curves were derived from actual gaugings or from hydraulic modelling. For this study, the rating curves were verified and then modified and/or extended if necessary, using hydraulic modelling where detailed LiDAR data is available.

Figure 3.1 to Figure 3.4 compare the Whitehaven rating curves, the TUFLOW model generated rating curves and the final adopted rating curves for the Taurus Creek D/S, Two Mile Gully, Burngrove Creek U/S and Sirius Creek D/S gauges, respectively. For these four gauges, the “adopted” rating curves were used to convert recorded water levels into discharges for the hydrologic model calibration.

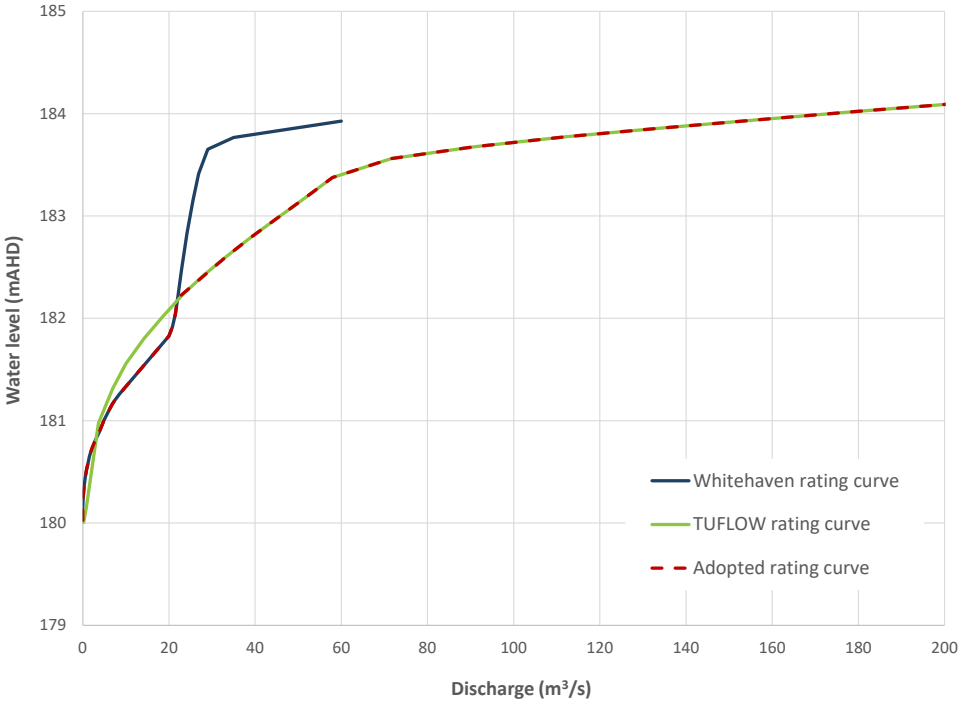


Figure 3.1 Comparison of Whitehaven-supplied, TUFLOW and adopted rating curves, Taurus Creek D/S gauging station

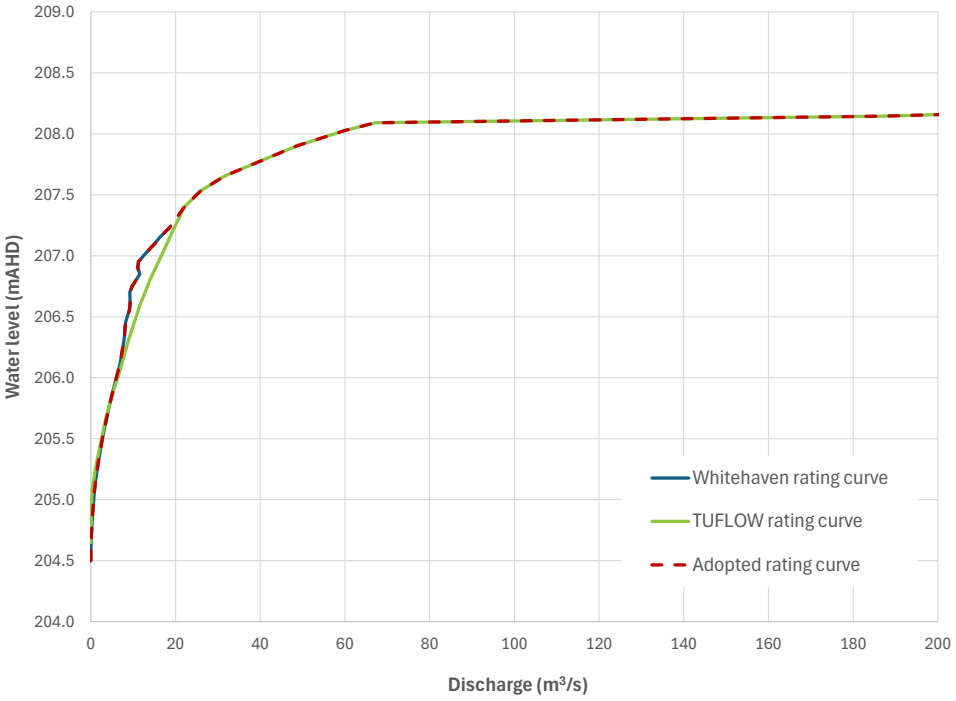


Figure 3.2 Comparison of Whitehaven-supplied, TUFLOW and adopted rating curves, Two Mile Gully gauging station

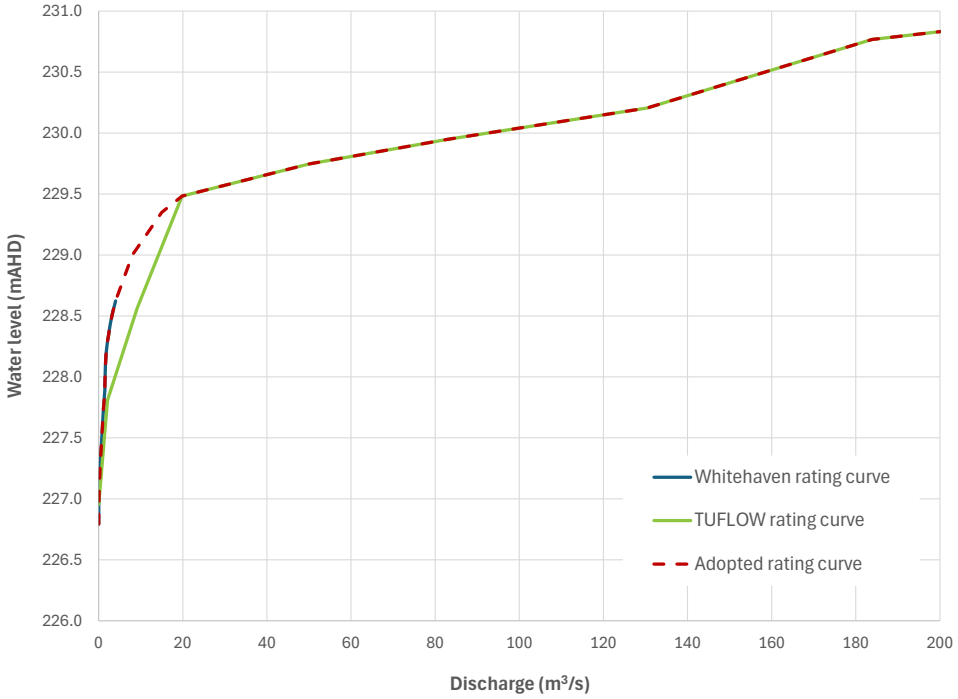


Figure 3.3 Comparison of Whitehaven-supplied, TUFLOW and adopted rating curves, Burngrove Creek U/S gauging station

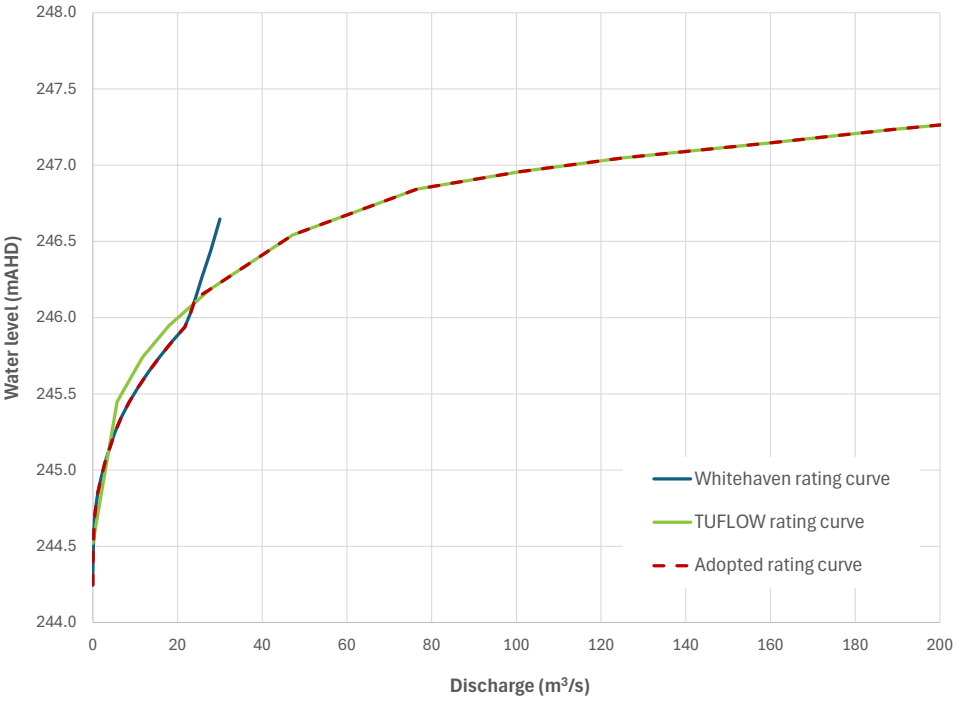


Figure 3.4 Comparison of Whitehaven-supplied, TUFLOW and adopted rating curves, Sirius Creek D/S gauging station

3.4 TOPOGRAPHIC DATA

The available topographic data used for this study is described as follows:

- A 1 m resolution LiDAR covering the BWM mine lease area captured in February 2024 (referred to as the 2024 LiDAR data);
- A 1 m resolution LiDAR covering the active mining pits of BWM captured in February 2025 (referred to as the 2025 LiDAR data); and
- A 30 m resolution Copernicus Digital Surface Model (DSM) satellite ground level observation data obtained from the European Space Programme on 31 January 2025 (referred to as the Copernicus DSM data).

4 HYDROLOGIC MODEL DEVELOPMENT

4.1 OVERVIEW

A total of seven URBS hydrologic models were developed for the following catchments:

- Bonnie Doon Creek;
- Blackwater Creek (including Taurus Creek and Two Mile Gully);
- Burngrove Creek;
- Rockland Creek;
- Sagittarius Creek;
- Sirius Creek;
- Speculation Creek.

URBS is a runoff-routing computer model that uses a network of conceptual storages to represent the routing of rainfall excess through a catchment. The URBS model was used in the "split mode" which enables the separate simulation of catchment and channel routing.

The initial and continuing loss method was adopted for this study. This model assumes that there is an initial loss (IL) in mm before any rainfall becomes runoff. After this, a continuing loss (CL) rate in mm per hour is applied to the rainfall.

Full details of the URBS model and its features are given in the URBS User Manual (Carroll, 2021).

The following three models were calibrated to recorded data for the March 2017 and January 2020 flood events:

- Burnrgrove Creek;
- Blackwater Creek (including Taurus Creek and Two Mile Gully);
- Sirius Creek.

The above three models were selected for calibration due to due to having stream gauging stations located in areas where detailed LiDAR data is available. This allowed for the rating curves to be verified using hydraulic model results.

The following is of note with regard to the remaining four models:

- Bonnie Doon Creek, Sagittarius Creek and Rockland Creek – There are no stream gauging stations within this catchment and hence, a model calibration cannot be undertaken for this catchment.
- Speculation Creek – The supplied rating curve for the Speculation Creek D/S gauge does not capture the peak flows that occurred in the March 2017 and January 2020 events. In addition, the Speculation Creek D/S gauging station is located outside of the detailed 2024 LiDAR data extent and as such, the supplied rating curve cannot be verified using hydraulic modelling.

The URBS models were then used to estimate design discharges for the 1% AEP event. The 1% AEP design discharge estimates were validated against estimates derived using the Rational Method, the Quantile Regression Technique (QRT) and the Regional Flood Frequency Estimation (RFFE) method.

4.2 MODEL CONFIGURATION

4.2.1 Subcatchment parameters

The URBS model subcatchments were assigned with area, slope, imperviousness, and PERN parameters. Subcatchment slopes were calculated using based on the available topographic data. The spatial configuration of the seven URBS models are summarised below.

4.2.1.1 Bonnie Doon Creek (BDC)

Figure A.1 in Appendix A shows the URBS model subcatchments adopted for the BDC model. The model covers an area of 21.6 km^2 and consists of 18 subcatchments, ranging in size from 0.17 km^2 to 2.46 km^2. Table A.1 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.2 Sagittarius Creek (SGC)

Figure A.2 in Appendix A shows the URBS model subcatchments adopted for the SGC model. The model covers a catchment area of 42.7 km^2 and consists of 28 subcatchments, ranging in size from 0.02 km^2 to 3.34 km^2. Table A.2 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.3 Burngrove Creek (BGC)

Figure A.3 in Appendix A shows the URBS model subcatchments adopted for the BGC model. The model covers an area of 79.2 km^2 and consists of 54 subcatchments, ranging in size from 0.06 km^2 to 5.72 km^2. Table A.3 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.4 Blackwater Creek (BWC)

Figure A.4 in Appendix A shows the URBS model subcatchments adopted for the BWC model. The model covers an area of 509.8 km^2 and consists of 226 subcatchments, ranging in size from 0.02 km^2 to 17.8 km^2. Table A.4 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.5 Speculation Creek (SPC)

Figure A.5 in Appendix A shows the URBS model subcatchments adopted for the SPC model. The model covers an area of 60.31 km^2 and consists of 39 subcatchments, ranging in size from 0.07 km^2 to 4 km^2. Table A.5 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.6 Sirius Creek (SRC)

Figure A.6 in Appendix A shows the URBS model subcatchments adopted for the SRC model. The model covers an area of 162 km^2 and consists of 85 subcatchments, ranging in size from 0.13 km^2 to 6.15 km^2. Table A.6 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.7 Rockland Creek (RLC)

Figure A.7 in Appendix A shows the URBS model subcatchments adopted for the SRC model. The model covers ant area of 158.6 km^2 and consists of 62 subcatchments, ranging in size from 0.14 km^2 to 8.5 km^2. Table A.7 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.2 Adopted global URBS model parameters

The global URBS model parameters included channel lag parameter (alpha), catchment storage parameter (beta), catchment non-linearity (M) and channel routing exponent (N). The following global URBS parameters were adopted for all seven models:

- Channel routing “alpha” (α) = 0.1
- Catchment routing “beta” (β) = 1.0
- Catchment routing exponent (M) = 0.715
- Channel routing exponent (N) = 1.0

4.3 INITIAL AND CONTINUING LOSSES

The initial loss (IL) and continuing loss (CL) method of accounting for rainfall losses was adopted for this study. For the calibration events, different initial and continuing losses were derived for each calibration event to reflect different antecedent catchment conditions (refer to Section 5.3). Design event ILs and CLs were derived during the model validation process (refer to Section 6.2.2).

5 HYDROLOGIC MODEL CALIBRATION

5.1 METHODOLOGY

The URBS models for the Burngrove Creek, Blackwater Creek and Sirius Creek were calibrated for the March 2017 and January 2020 flood events. The purpose of the model calibration was to achieve the best possible match between URBS-modelled discharge hydrographs against the recorded discharge hydrographs, using a common set of model parameters between flood events.

5.2 SELECTION OF CALIBRATION EVENTS

5.2.1 Overview

The March 2017 and January 2020 flood events were selected for calibration due to the availability of data and because the rainfalls during these events triggered similar responses at all catchments for which data is available. The March 2017 and January 2020 events were also the selected calibration events in the GHD (2021) study.

Table 5.1 shows the adopted historical event simulation periods for the calibration events in the URBS model. Table 5.2 shows the recorded rainfall depths at each station for the calibration events. Table 5.3 shows the recorded peak discharges at each gauging station for the calibration events.

Table 5.1 Calibration event simulation periods

Calibration Event	Simulation period
March 2017	28 March (0000 hours) – 1 April (0000 hours) - 4 days
January 2020	24 January (0000 hours) – 27 January (0000 hours) - 3 days

Table 5.2 Total rainfall depths recorded during the 2017 and 2020 events

Station Number	Station Name	Rainfall depth (mm)	
		March 2017	January 2020
330107	Central WS	119.0	148.0
330122	Northern WS	139.5	78.5
330123	Southern WS	142.5	49.5

Table 5.3 Peak discharges recorded during calibration events

Station Number	Station Name	Peak discharge (m^3/s)	
		March 2017	January 2020
330127	Burngrove Creek U/S	78.5	22.2
330101	Taurus Creek D/S	117	156.8
330124	Two Mile Gully	16.2	50.4
330118	Sirius Creek D/S	15.9	8.6

5.2.2 March 2017 event

Figure B.1 to Figure B.3 (Appendix B) show the rainfall intensity recorded at each available rainfall station listed in Table 5.2 over the period 0000 hours on 28 March 2017 to 0000 hours on 1 April 2017 within and near the catchments of interest. The highest rainfall intensity of 29 mm/h was recorded in the at the Southern WS Station (330123).

Figure B.4 to Figure B.8 (Appendix B) shows the recorded water levels at the stations listed in Table 5.3 over the same period.

5.2.3 January 2020 event

Figure B.9 to Figure B.11 (Appendix B) show the rainfall intensity recorded at each available rainfall station listed in Table 5.2 over the period 0000 hours on 24 January 2020 to 0000 hours on 27 January 2020 within and near the catchments of interest. The highest rainfall intensity of 46 mm/h was recorded at the Central WS Station (330107).

Figure B.12 to Figure B.16 (Appendix B) shows the recorded water levels at the stations listed in Table 5.3 over the same period.

5.2.4 Assignment of subcatchment rainfalls

Each URBS subcatchment was assigned a rainfall hyetograph based on the three nearest pluviograph stations, using the URBS SUBRAIN utility. The SUBRAIN utility calculates the weighted average rainfall depth for each subcatchment using an inverse distance squared method based on the relative distance between the rainfall station location and the subcatchment centroid.

5.3 INITIAL AND CONTINUING LOSSES

Table 5.4 shows the IL and CL adopted for the Blackwater Creek, Burngrove Creek and Sirius Creek catchments for the two calibration events. A CL of 3.5 mm/h was adopted for all three models and for all events. Different ILs were adopted for each model and for each event which reflect the different antecedent conditions prior to each event.

Table 5.4 Adopted initial and continuing losses

Model	March 2017		January 2020	
	IL (mm)	CL (mm/h)	IL (mm)	CL (mm/h)
BGC	52	3.5	53	3.5
BWC	82	3.5	75	3.5
SRC	125	3.5	73	3.5

5.4 MODEL CALIBRATION RESULTS

5.4.1 Overview

Table 5.5 shows the comparison of the calculated and recorded peak discharges at the four gauging stations for the 2017 and 2020 events.

Table 5.5 Summary of calibration results

Station Number	Station Name	Peak discharge (m^3/s)					
		March 2017			January 2020		
		Calculated	Recorded	Difference (%)	Calculated	Recorded	Difference (%)
330127	Burngrove Creek U/S	57.4	56.5	1.5%	22.5	22.2	1%
330101	Taurus Creek D/S	116.6	117.0	-0.3%	155.6	156.8	-1%
330124	Two Mile Gully	46.9	16.2	189.4%	79.1	50.4	57%
330118	Sirius Creek D/S	12.2	11.9	2.3%	9.0	8.6	4%

5.4.2 March 2017 event calibration results

Figure 5.1 to Figure 5.4 compare the modelled / calculated (C) and recorded (R) discharge hydrographs for the March 2017. The calibration results for the March 2017 event are summarised below.

- In Burngrove Creek, the calibration is considered good, with the modelled (calculated) hydrograph matching well with the recorded hydrograph peak, shape and timing at the Burngrove Creek U/S gauge.
- In Taurus Creek and Two Mile Gully:
  - The modelled (calculated) hydrograph matches well with the recorded hydrograph peak and shape at the Taurus Creek D/S gauge. However, the URBS model could not reproduce the recorded hydrograph shape, peak or timing further upstream at the Two Mile Gully gauge.
  - The recorded data suggests that the Two Mile Gully gauge appears to have malfunctioned during the event, as indicated by the following:

- The recorded water level hydrograph shape at the Two Mile Gully gauge is inconsistent with the recorded water levels at the Taurus Creek gauge (refer to Figure B.5 and B.6 in Appendix B).
- The catchment area to Two Mile Gully is around 27% of the catchment area to the Taurus Creek D/S gauge. Despite this, the recorded peak discharge at Two Mile Gully D/S is only 14% of the recorded peak discharge at Taurus Creek D/S. This indicates that the Two Mile Gully gauge likely did not capture the peak water level (and hence the peak discharge) during this event.
- In consideration of the above, the calibration in Two Mile Gully and Taurus Creek is considered acceptable.

- In Sirius Creek:
  - The modelled (calculated) hydrograph generally matches the recorded hydrograph shape and peak, but the timing of the modelled flood peak is significantly delayed compared to the recorded peak.
  - The reason for the discrepancy in timing between the modelled and recorded flood peak is uncertain. The catchment area to the Sirius Creek gauge is around 120 km^2 and on this basis, the flood peak is expected to occur much later than what the data is suggesting, similar to observations at the Taurus Creek and Two Mile Gully gauges for this event. This suggests that there could be an issue with the timing of the recorded water levels at the Sirius Creek gauge, but further investigation is required to confirm this.
  - In consideration of the above, the calibration in Sirius Creek is considered acceptable.

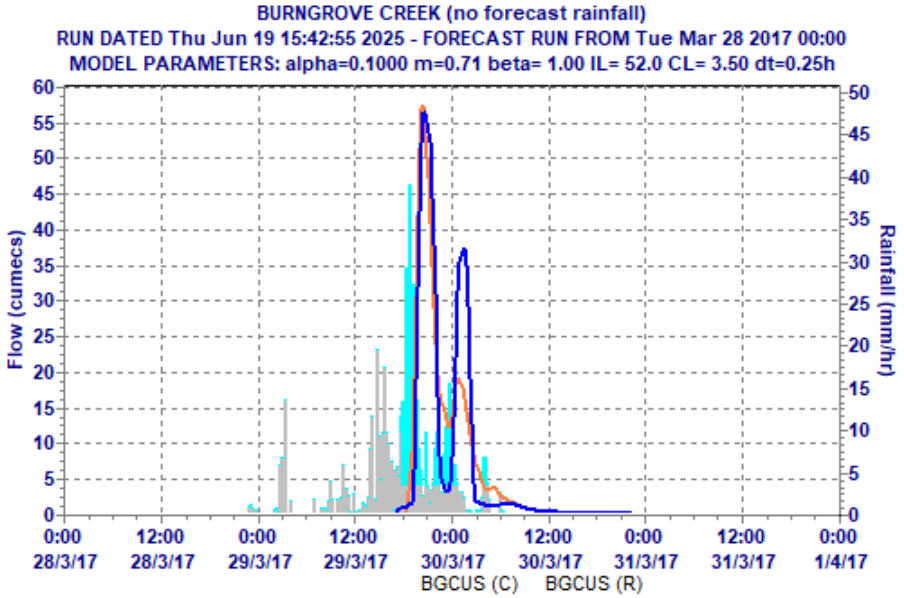


Figure 5.1 Calculated (C) and recorded (R) discharge hydrographs for March 2017 event at Burngrove Creek

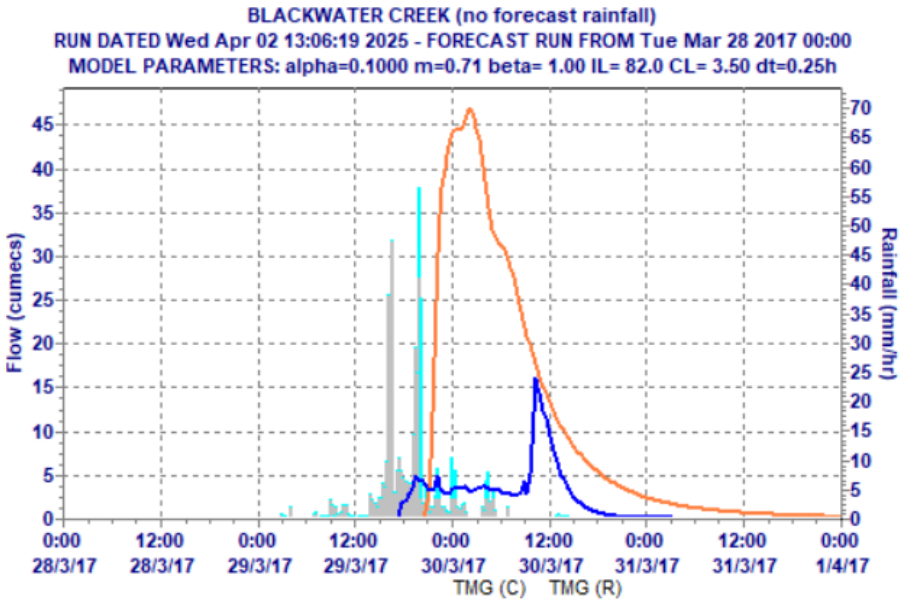


Figure 5.2 Calculated (C) and recorded (R) discharge hydrographs for March 2017 event at Two Mile Gully

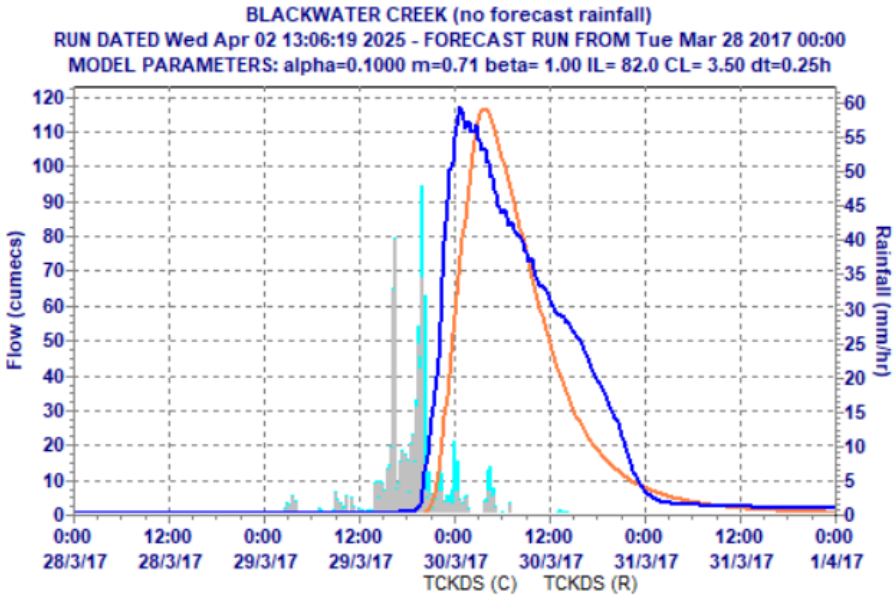


Figure 5.3 Calculated (C) and recorded (R) discharge hydrographs for March 2017 event at Taurus Creek

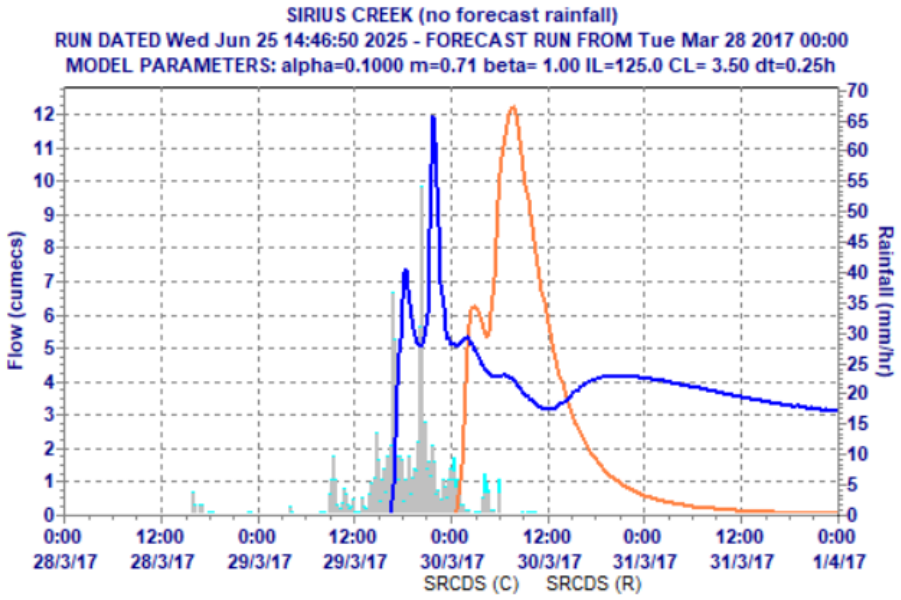


Figure 5.4 Calculated (C) and recorded (R) discharge hydrographs for March 2017 event at Sirius Creek

5.4.3 January 2020 event calibration results

Figure 5.5 to Figure 5.4 compare the modelled / calculated (C) and recorded (R) discharge hydrographs for the March 2017. The calibration results for the March 2017 event are summarised below

- In Burngrove Creek, the calibration is considered good, with the modelled (calculated) hydrograph matching well with the recorded hydrograph peak, shape and timing at the Burngrove Creek U/S gauge.
- In Taurus Creek and Two Mile Gully:
  - The modelled (calculated) hydrograph matches well with the recorded hydrograph peak and shape at the Taurus Creek D/S gauge. However, the URBS model could not reproduce the recorded hydrograph shape, peak or timing further upstream at the Two Mile Gully gauge.
  - Compared to the March 2017 event, there are similar discrepancies observed between the recorded water level hydrographs at Two Mile Gully and Taurus Creek D/S for the January 2020 event. This suggests that the Two Mile Gully gauge may not have accurately captured the peak flood level (and hence the peak discharge) during the January 2020 event, due to similar reasons described in Section 5.4.2 for the March 2017 event.
  - In consideration of the above, the calibration in Two Mile Gully and Taurus Creek is considered acceptable.
- In Sirius Creek:
  - The modelled (calculated) hydrograph generally matches the recorded hydrograph shape and peak, but the timing of the modelled flood peak is significantly delayed compared to the recorded peak.
  - The reason for the discrepancy in timing between the modelled and recorded flood peak is uncertain, but it is similar to the calibration results for the March 2017 event at this gauge

(refer to Section 5.4.2). This further suggests that there could be an issue with the timing of the recorded water levels at the Sirius Creek gauge, but further investigation is required to confirm this.

- In consideration of the above, the calibration in Sirius Creek is considered acceptable.

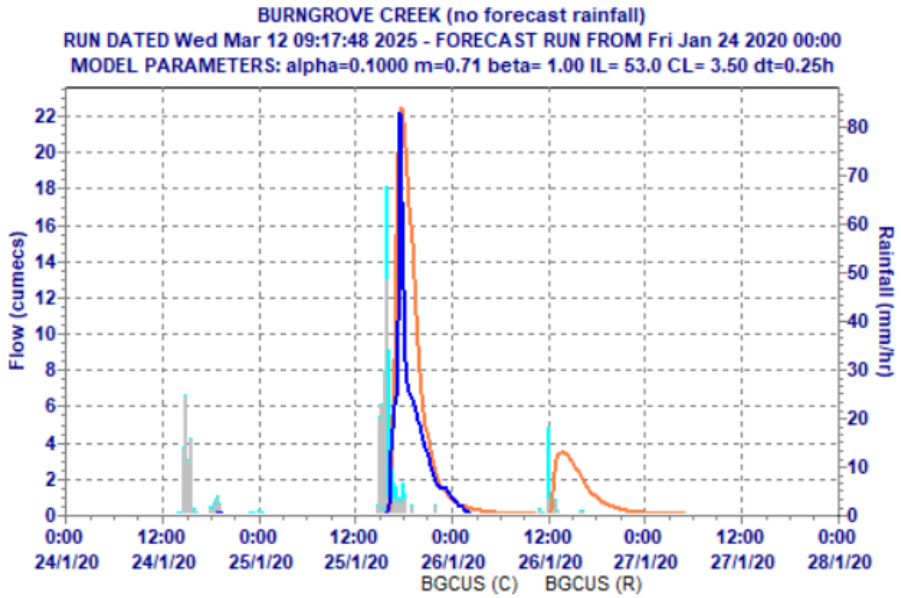


Figure 5.5 Calculated (C) and recorded (R) discharge hydrographs for January 2020 event at Burngrove Creek

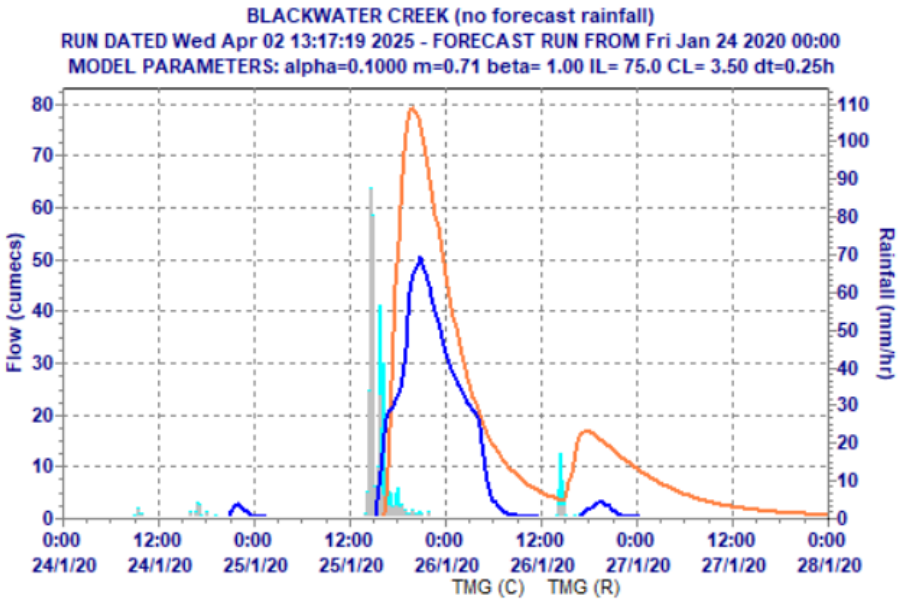


Figure 5.6 Calculated (C) and recorded (R) discharge hydrographs for January 2020 event at Two Mile Gully

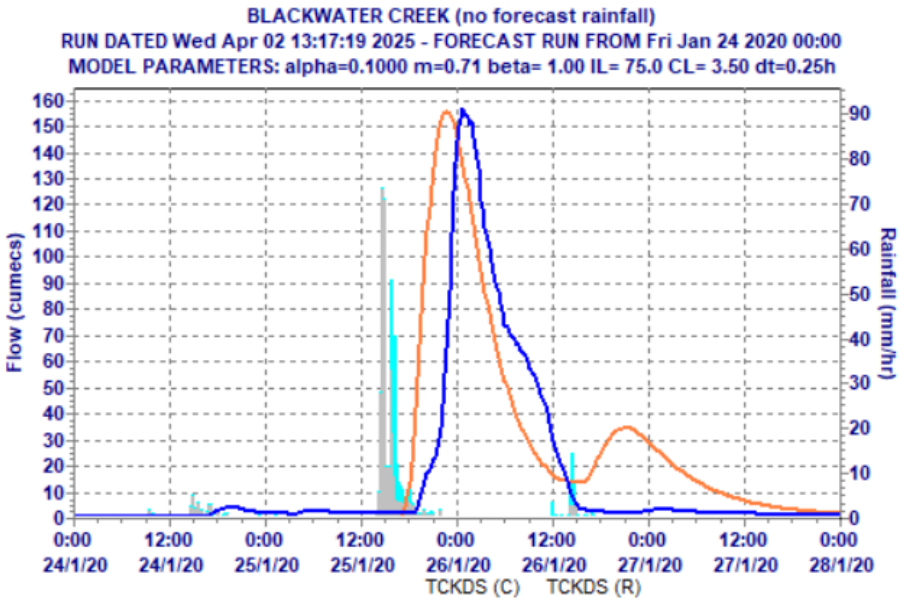


Figure 5.7 Calculated (C) and recorded (R) discharge hydrographs for January 2020 event at Taurus Creek

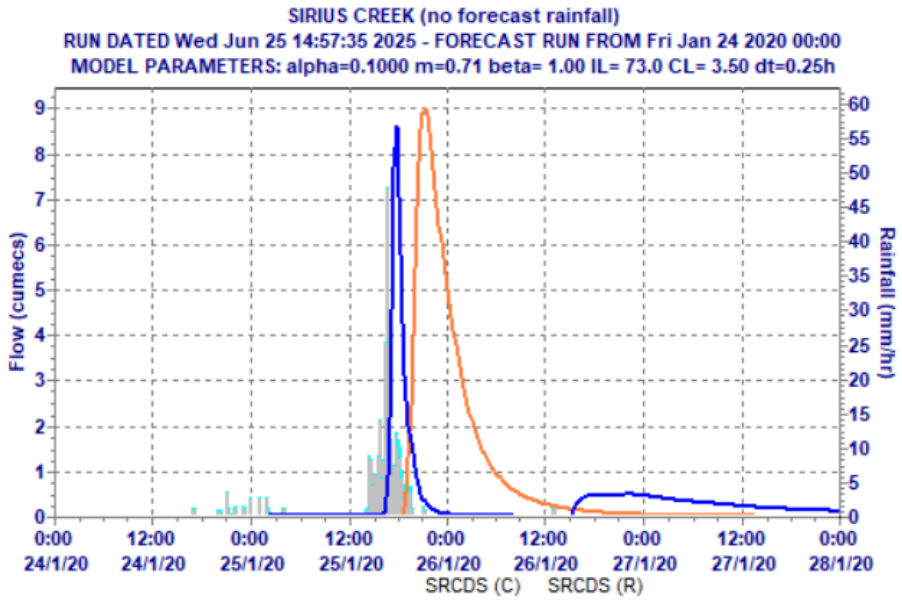


Figure 5.8 Calculated (C) and recorded (R) discharge hydrographs for January 2020 event at Sirius Creek

6 DESIGN DISCHARGE ESTIMATION AND VALIDATION

6.1 METHODOLOGY

URBS model design discharge estimates for all seven models were validated against discharge estimates derived using the Rational Method (RM), the Quantile Regression Technique (QRT) (Palmen and Weeks, 2015) and the Regional Flood Frequency Analysis (RFFE) method. Design peak discharges were validated for the 1% AEP event only, at key validation locations shown in Figure 6.1, which were selected to allow comparison of design discharges from all of the above-mentioned methods at the same location.

6.2 URBS MODEL PARAMETERS

6.2.1 Global model parameters

The global URBS model parameters (alpha, beta, M and N) given in Section 4.2.2 were adopted for design event modelling for all models.

6.2.2 Initial and continuing losses

Table 6.1 shows the ILs and CLs adopted for 1% AEP design event in each model.

The design event ILs are generally lower than those adopted for the calibration events (refer to Section 5.3). This reflects the high degree of catchment saturation that is expected prior to the main rainfall burst during rare events such as the 1% AEP. In comparison, the March 2017 and January 2020 calibration events were much smaller and more frequent events than a 1% AEP design event.

The adopted CLs for the seven models are generally consistent with the calibration event CLs (3.5 mm/h) except for the Rockland Creek and Sagittarius Creek models. Lower CLs were adopted for these models to achieve a better match between URBS model peak discharges and those derived from empirical methods.

Table 6.1 Adopted design event initial and continuing losses for the 1% AEP event

URBS Model	1% AEP losses	
	IL (mm)	CL (mm/h)
Bonnie Doon Creek (BDC)	5	3.5
Burngrove Creek (BGC)	35	3.5
Sagittarius Creek (SGC)	0	2
Blackwater Creek (BWC)	0	3.5
Speculation Creek (SPC)	0	3.5
Sirius Creek (SRC)	50	3.5
Rockland Creek (RLC)	0	2

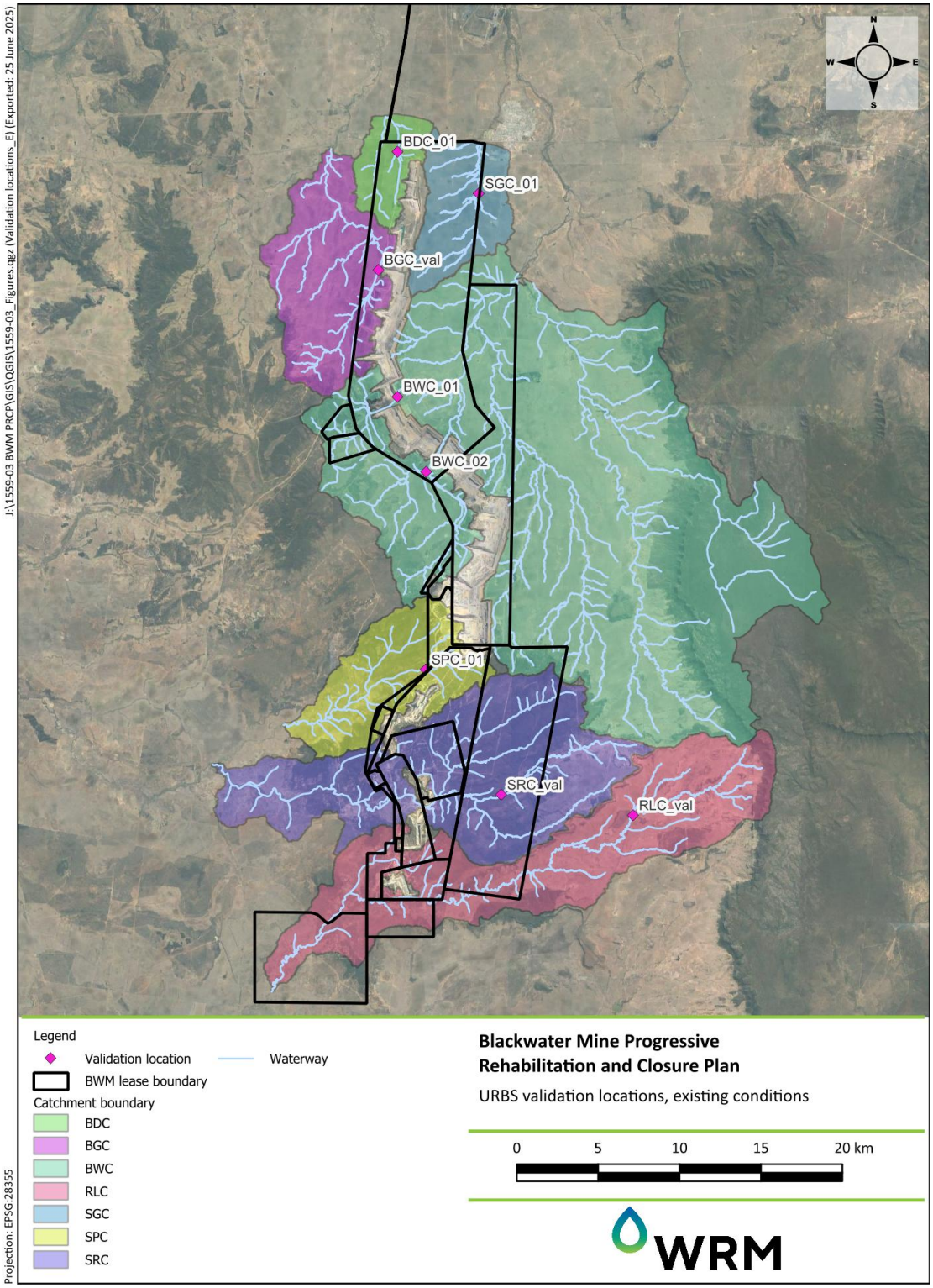


Figure 6.1 URBS validation locations

6.3 ADJUSTMENT FOR CLIMATE CHANGE

Based on the latest guidance on climate change provided in ARR 2019 v4.2, global temperatures have already risen since the baseline historical rainfall data midpoint of 1961-1990. Therefore, to assess current (2025) flood risks, design rainfall estimates require factoring up to account for this temperature increase that has already occurred.

Design Intensity-Frequency-Duration (IFD) design rainfall intensities were scaled up using uplift factors obtained from ARR datahub[1], corresponding to the SSP5-8.5 (year 2030) climate scenario. The associated pre-burst rainfalls were also scaled up accordingly.

The SSP5-8.5 climate adjustments account for approximately 1.3°C of global warming up to 2025 since the historical baseline period of 1961-1990. Table 6.2 shows the corresponding 1% AEP design rainfall uplift factors for various storm durations (as percentage increases compared to the baseline).

Table 6.2 Adopted design rainfall uplift factors (SSP5-8.5 year 2030)

Storm duration	Rainfall uplift factor
<1 hour	20%
1.5 Hours	18%
2 Hours	17%
3 Hours	16%
4.5 Hours	14%
6 Hours	13%
9 Hours	13%
12 Hours	12%
18 Hours	11%
>24 Hours	11%

6.4 MODEL VALIDATION RESULTS

Table 6.3 compares the URBS peak discharges for the 1% AEP design events against discharges estimated using the Rational Method, QRT and RFFE methods. For the RFFE, design peak discharges were estimated using both the 2016 and 2021 versions of the RFFE.

The validation results show that the URBS model predicted design peak discharges generally correspond well (within 20%) to the Rational Method and QRT design peak discharge estimates. However, the differences between URBS and RFFE peak discharges are greater.

There is considerable uncertainty in the RFFE design peak discharges, which are reliant upon the accuracy of Flood Frequency Analysis results from nearby gauged catchments. However, the URBS model predicted design peak discharges are generally within the range of uncertainty (i.e. 5th to 95th percentile) of the RFFE peak discharge estimates.

[1] https://data.arr-software.org/

Table 6.3 Model validation results for the 1% AEP event

Location (Figure 6.1)	1% AEP design peak discharge (m^3/s)					
	URBS	QRT	Rational Method	RFFE		
				Flow	5%ile	95%ile
BDC	78	77	73	316	83	1,102
BGC	259	203	222	493	144	1,550
BWC_L1	172	174	191	520	140	1,796
BWC_L2	190	189	176	471	130	1,596
RLC	110	176	119	785	212	2,758
SGC	147	182	170	535	141	1,868
SPC	117	116	133	583	155	2,049
SRC	203	190	168	1,084	304	3,672

7 REFERENCES

Ball et al, 2019	Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I (Editors), 2019, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia.
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PPK, 1994	PPK Consultants Pty Ltd, March 1994, *Rockland Creek Diversion Construction Report*
SLR, 2024a	SLR Consulting Australia Pty Ltd, 10 October 2024, *Blackwater Mine Progressive Rehabilitation and Closure Plan – Voids in Floodplain Modelling*
SLR, 2024b	SLR Consulting Australia Pty Ltd, 10 October 2024, *Blackwater Mine Progressive Rehabilitation and Closure Plan – Rehabilitation Flood Assessments*
WRM, 2025a	WRM Water & Environment Pty Ltd, November 2025, *Blackwater Mine Progressive Rehabilitation and Closure Plan – Void in Floodplain Modelling*
WRM, 2025b	WRM Water & Environment Pty Ltd, November 2025, *Blackwater Mine Progressive Rehabilitation and Closure Plan – Final Landform Flood Modelling*

APPENDIX A URBS MODEL CONFIGURATION

A.1 BDC CATCHMENT

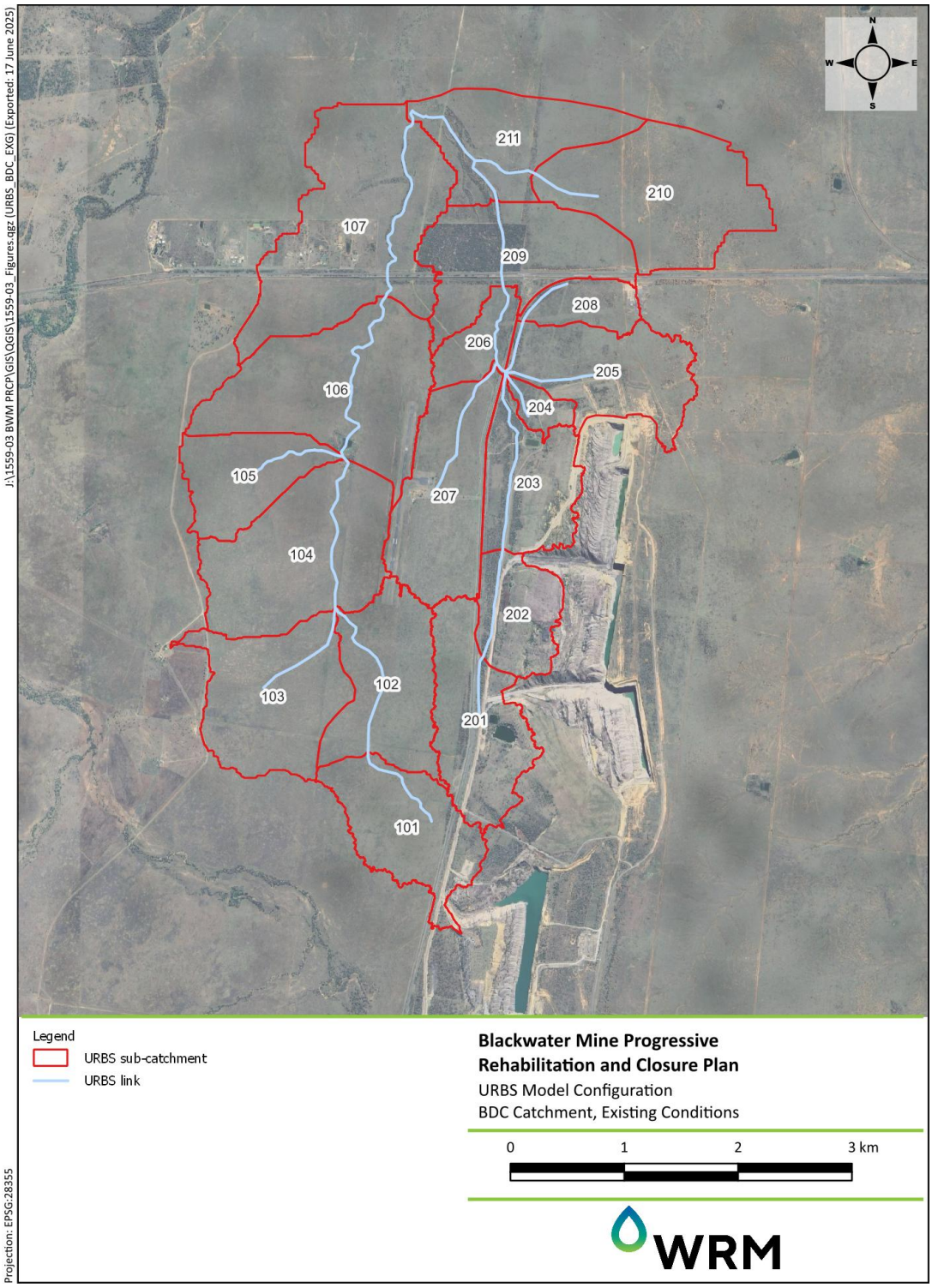


Figure A.1 URBS model configuration of the BDC catchment

Table A.1 URBS catchment parameters of the BDC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.15	0	0.07	0.007
102	1.26	0	0.07	0.006
103	1.46	0	0.07	0.010
104	1.83	0	0.07	0.007
105	0.83	0	0.07	0.011
106	2.02	0	0.07	0.005
107	2.46	0	0.07	0.007
201	1.20	0	0.07	0.009
202	0.68	0	0.07	0.015
203	0.95	0	0.07	0.009
204	0.17	0	0.07	0.012
205	1.16	0	0.07	0.006
206	0.39	0	0.07	0.005
207	1.36	0	0.07	0.007
208	0.38	0	0.07	0.006
209	1.39	0	0.07	0.007
210	1.72	0	0.07	0.006
211	1.19	0	0.07	0.005

A.2 SGC CATCHMENT

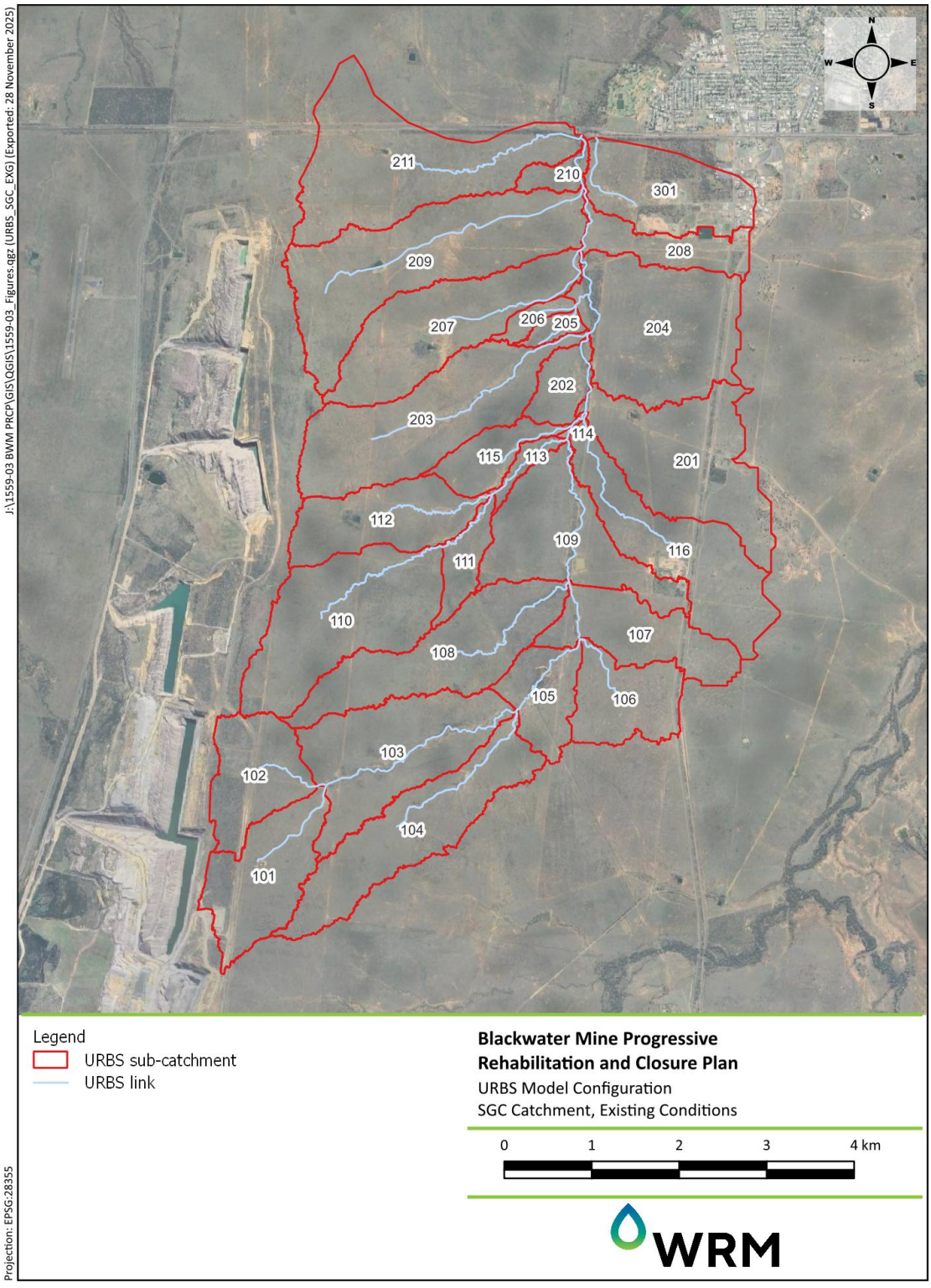


Figure A.2 URBS model configuration of the SGC catchment

Table A.2 URBS catchment parameters of the SGC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.58	0	0.07	0.009
102	1.29	0	0.07	0.008
103	2.37	0	0.07	0.007
104	2.19	0	0.07	0.007
105	0.87	0	0.07	0.007
106	1.14	0	0.07	0.008
107	1.37	0	0.07	0.009
108	2.2	0	0.07	0.008
109	2.02	0	0.07	0.007
110	2.69	0	0.07	0.008
111	0.46	0	0.07	0.009
112	1.46	0	0.07	0.009
113	0.19	0	0.07	0.007
114	0.02	0	0.07	0.005
115	0.63	0	0.07	0.007
116	2.12	0	0.07	0.007
201	2.44	0	0.07	0.01
202	0.51	0	0.07	0.004
203	2.72	0	0.07	0.007
204	2.69	0	0.07	0.01
205	0.17	0	0.07	0.007
206	0.2	0	0.07	0.007
207	2.22	0	0.07	0.008
208	0.81	0	0.07	0.008
209	3.34	0	0.07	0.007

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
210	0.27	0	0.07	0.003
211	3.14	0	0.07	0.005
301	1.58	0	0.07	0.008

A.3 BGC CATCHMENT

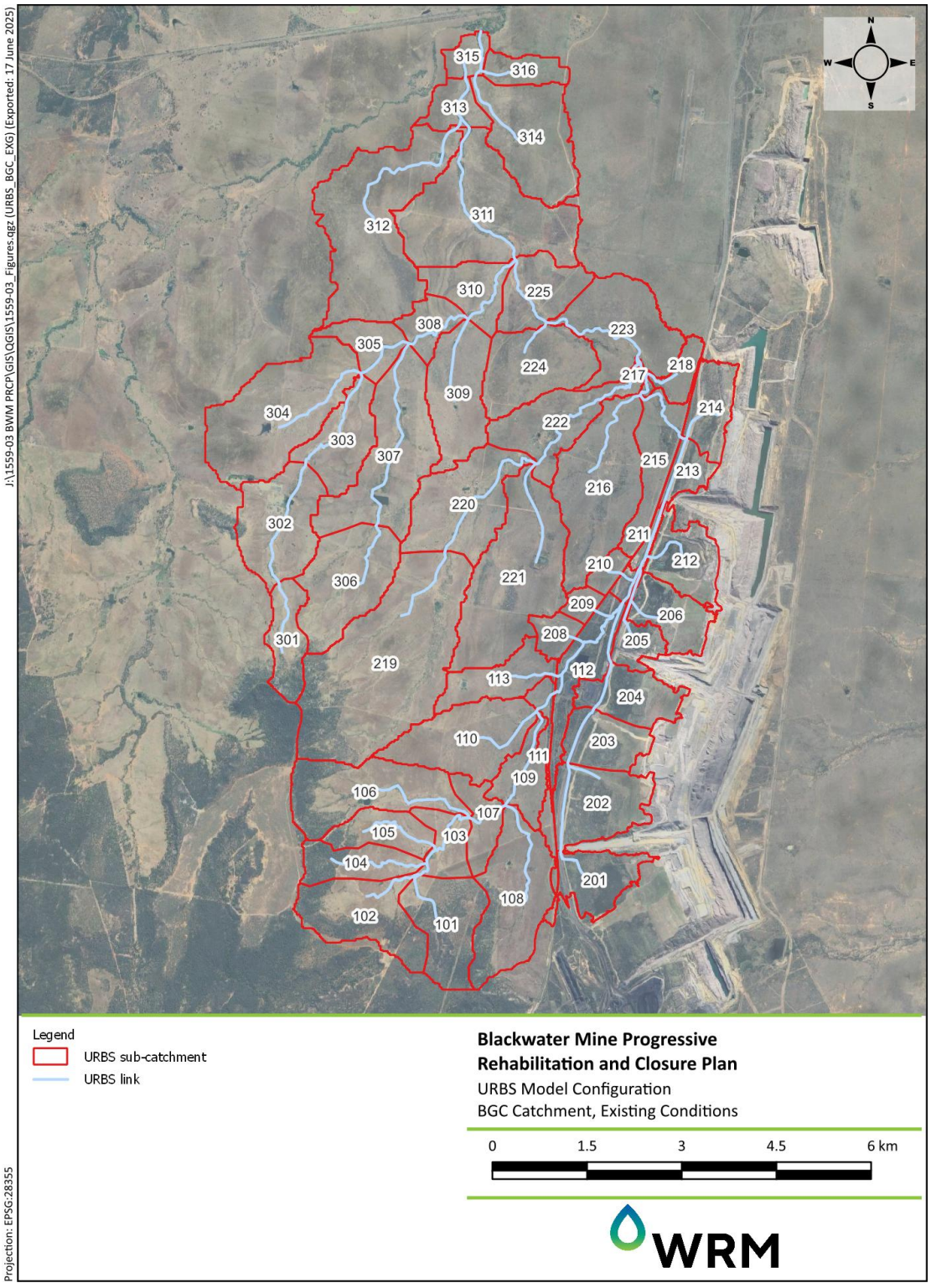


Figure A.3 URBS model configuration of the BGC catchment

Table A.3 URBS catchment parameters of the BGC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.66	0	0.035	0.017
102	1.90	0	0.035	0.019
103	0.72	0	0.035	0.007
104	0.96	0	0.035	0.010
105	0.89	0	0.035	0.009
106	2.25	0	0.035	0.023
107	0.72	0	0.035	0.007
108	2.37	0	0.035	0.024
109	0.87	0	0.035	0.009
110	2.07	0	0.035	0.021
111	0.54	0	0.035	0.005
112	1.22	0	0.035	0.012
113	1.04	0	0.035	0.010
201	1.10	0	0.035	0.011
202	1.63	0	0.035	0.016
203	1.06	0	0.035	0.011
204	1.14	0	0.035	0.011
205	0.55	0	0.035	0.006
206	1.03	0	0.035	0.010
207	0.15	0	0.035	0.002
208	0.41	0	0.035	0.004
209	0.25	0	0.035	0.003
210	0.27	0	0.035	0.003
211	0.17	0	0.035	0.002
212	1.16	0	0.035	0.012

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
213	0.50	0	0.035	0.005
214	0.93	0	0.035	0.009
215	1.26	0	0.035	0.013
216	2.89	0	0.035	0.029
217	0.06	0	0.035	0.001
218	0.42	0	0.035	0.004
219	5.72	0	0.035	0.057
220	2.24	0	0.035	0.022
221	3.52	0	0.035	0.035
222	1.69	0	0.035	0.017
223	2.17	0	0.035	0.022
224	1.87	0	0.035	0.019
225	1.26	0	0.035	0.013
301	0.93	0	0.035	0.009
302	2.00	0	0.035	0.020
303	1.33	0	0.035	0.013
304	3.27	0	0.035	0.033
305	0.76	0	0.035	0.008
306	2.17	0	0.035	0.022
307	2.89	0	0.035	0.029
308	0.63	0	0.035	0.006
309	1.81	0	0.035	0.018
310	1.00	0	0.035	0.010
311	3.79	0	0.035	0.038
312	4.12	0	0.035	0.041

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
313	0.61	0	0.035	0.006
314	2.26	0	0.035	0.023
315	0.40	0	0.035	0.010
316	0.58	0	0.035	0.010

A.4 BWC CATCHMENT

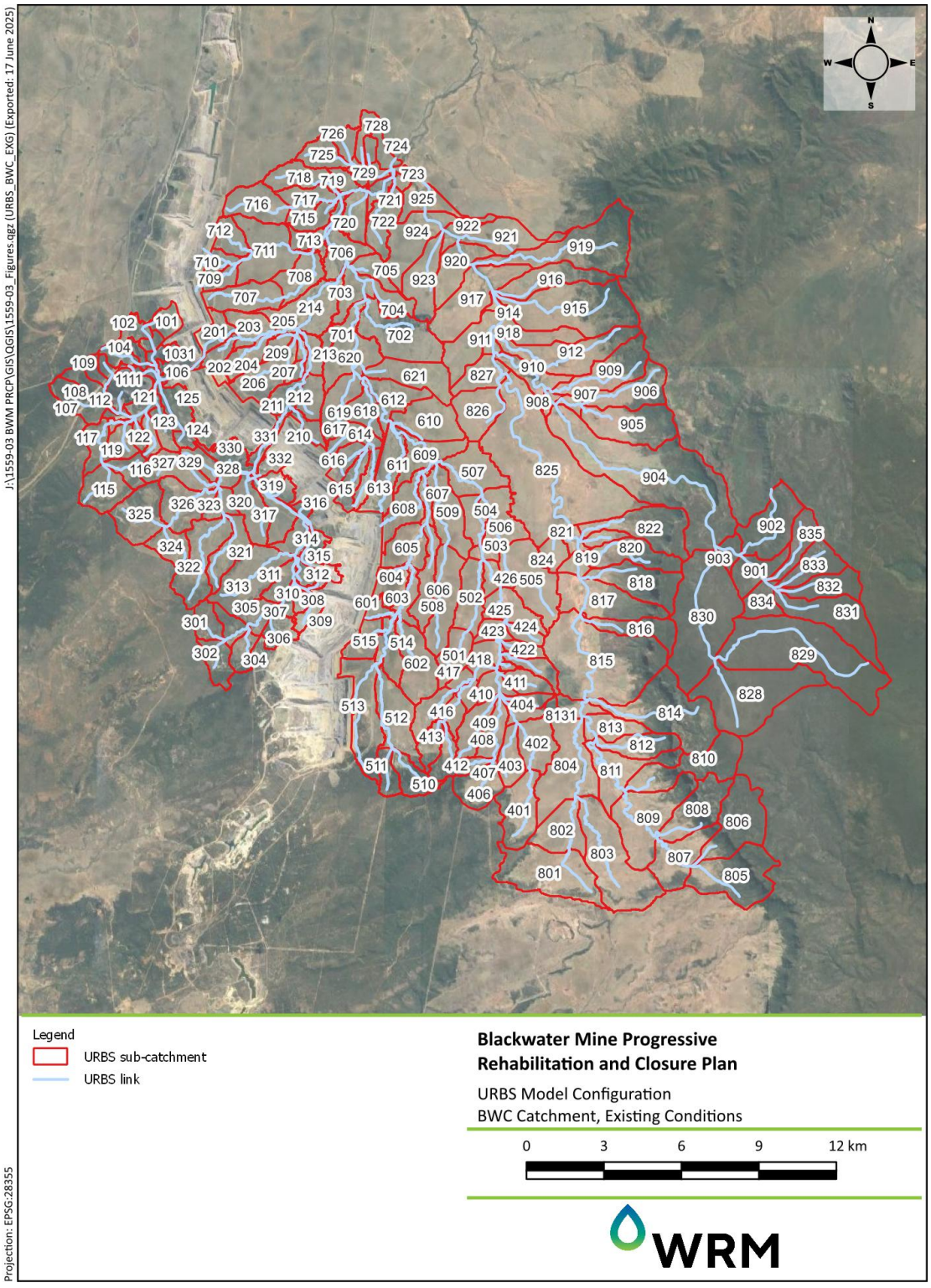


Figure A.4 URBS model configuration of the BWC catchment

Table A.4 URBS catchment parameters of the BWC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.11	0	0.07	0.019
102	0.88	0	0.07	0.009
103	0.47	0	0.07	0.022
104	0.97	0	0.07	0.028
105	0.51	0	0.07	0.021
106	0.37	0	0.07	0.004
107	2.02	0	0.07	0.030
108	1.10	0	0.04	0.070
109	0.65	0	0.07	0.028
110	0.42	0	0.07	0.044
111	0.02	0	0.07	0.006
112	0.10	0	0.07	0.009
113	1.94	0	0.07	0.005
114	0.33	0	0.07	0.020
115	2.55	0	0.07	0.017
116	1.21	0	0.07	0.015
117	1.61	0	0.07	0.012
118	0.28	0	0.07	0.010
119	1.14	0	0.07	0.036
120	0.50	0	0.07	0.029
121	0.95	0	0.07	0.009
122	0.79	0	0.07	0.023
123	1.05	0	0.07	0.018
124	0.60	0	0.07	0.027
125	1.72	0	0.07	0.013

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
201	1.45	0	0.07	0.006
202	1.26	0	0.07	0.012
203	1.77	0	0.07	0.007
204	1.65	0	0.07	0.008
205	0.32	0	0.07	0.002
206	2.94	0	0.07	0.008
207	0.46	0	0.07	0.007
208	0.39	0	0.07	0.003
209	0.67	0	0.07	0.008
210	0.83	0	0.07	0.010
211	1.36	0	0.07	0.006
212	1.54	0	0.07	0.011
213	1.04	0	0.07	0.004
214	3.78	0	0.07	0.004
301	1.34	0	0.07	0.033
302	1.71	0	0.07	0.018
303	1.05	0	0.07	0.026
304	1.20	0	0.07	0.026
305	1.23	0	0.07	0.009
306	1.29	0	0.07	0.019
307	0.62	0	0.07	0.019
308	0.56	0	0.07	0.037
309	0.83	0	0.07	0.044
310	0.10	0	0.07	0.016
311	1.08	0	0.07	0.015

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
312	0.69	0	0.07	0.030
313	4.53	0	0.07	0.017
314	1.21	0	0.07	0.004
315	1.44	0	0.07	0.007
316	0.39	0	0.07	0.074
317	1.80	0	0.07	0.009
318	0.78	0	0.07	0.053
319	0.35	0	0.07	0.085
320	2.47	0	0.07	0.013
321	2.35	0	0.07	0.017
322	4.18	0	0.07	0.016
323	1.05	0	0.07	0.013
324	1.70	0	0.07	0.019
325	3.44	0	0.07	0.023
326	3.05	0	0.07	0.013
327	2.58	0	0.07	0.013
328	0.66	0	0.07	0.004
329	1.04	0	0.07	0.015
330	1.44	0	0.07	0.018
331	0.80	0	0.07	0.006
332	0.57	0	0.07	0.029
401	3.50	0	0.07	0.015
402	2.59	0	0.07	0.011
403	1.73	0	0.07	0.012
404	0.92	0	0.07	0.017

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
405	0.74	0	0.07	0.032
406	2.38	0	0.07	0.018
407	0.62	0	0.07	0.027
408	1.72	0	0.07	0.012
409	2.13	0	0.07	0.015
410	1.21	0	0.07	0.007
411	1.35	0	0.07	0.030
412	1.33	0	0.07	0.022
413	1.28	0	0.07	0.024
414	0.97	0	0.07	0.016
415	0.66	0	0.07	0.015
416	1.65	0	0.07	0.013
417	0.55	0	0.07	0.011
418	0.57	0	0.07	0.011
419	0.21	0	0.07	0.018
420	1.00	0	0.07	0.015
421	1.25	0	0.07	0.026
422	0.87	0	0.07	0.015
423	1.00	0	0.07	0.008
424	0.79	0	0.07	0.016
425	2.31	0	0.07	0.009
426	1.00	0	0.07	0.005
501	2.03	0	0.07	0.010
502	2.62	0	0.07	0.006
503	0.56	0	0.07	0.005

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
504	1.46	0	0.07	0.005
505	4.78	0	0.07	0.007
506	2.93	0	0.07	0.006
507	3.35	0	0.07	0.004
508	3.88	0	0.07	0.006
509	3.46	0	0.07	0.006
510	1.80	0	0.07	0.032
511	1.23	0	0.07	0.031
512	3.76	0	0.07	0.015
513	4.77	0	0.07	0.013
514	1.85	0	0.07	0.007
515	1.57	0	0.07	0.012
601	0.63	0	0.07	0.012
602	3.63	0	0.07	0.008
603	1.13	0	0.07	0.005
604	1.69	0	0.07	0.011
605	2.43	0	0.07	0.006
606	2.29	0	0.07	0.007
607	0.69	0	0.07	0.004
608	2.44	0	0.07	0.005
609	2.66	0	0.07	0.006
610	3.38	0	0.07	0.006
611	2.97	0	0.07	0.007
612	2.44	0	0.07	0.006
613	1.09	0	0.07	0.009

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
614	0.38	0	0.07	0.006
615	1.36	0	0.07	0.007
616	1.19	0	0.07	0.010
617	1.02	0	0.07	0.013
618	1.58	0	0.07	0.003
619	2.57	0	0.07	0.009
620	3.14	0	0.07	0.008
621	3.18	0	0.07	0.009
701	1.23	0	0.07	0.005
702	4.86	0	0.07	0.007
703	1.79	0	0.07	0.005
704	1.35	0	0.07	0.006
705	1.22	0	0.07	0.012
706	2.13	0	0.07	0.005
707	2.90	0	0.07	0.008
708	2.27	0	0.07	0.007
709	0.93	0	0.07	0.010
710	0.89	0	0.07	0.012
711	4.49	0	0.07	0.008
712	1.47	0	0.07	0.012
713	1.27	0	0.07	0.004
714	0.55	0	0.07	0.002
715	1.15	0	0.07	0.006
716	2.84	0	0.07	0.011
717	1.89	0	0.07	0.009

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
718	2.25	0	0.07	0.008
719	0.73	0	0.07	0.007
720	1.69	0	0.07	0.005
721	0.77	0	0.07	0.004
722	2.29	0	0.07	0.009
723	0.36	0	0.07	0.002
724	0.88	0	0.07	0.008
725	1.67	0	0.07	0.007
726	1.07	0	0.07	0.007
727	0.61	0	0.07	0.008
728	0.92	0	0.07	0.012
729	0.52	0	0.07	0.004
730	0.46	0	0.07	0.012
801	6.29	0	0.07	0.011
802	3.02	0	0.07	0.013
803	7.28	0	0.07	0.009
804	6.31	0	0.07	0.009
805	5.39	0	0.07	0.075
806	4.86	0	0.07	0.108
807	3.45	0	0.07	0.040
808	3.68	0	0.07	0.107
809	5.80	0	0.07	0.044
810	4.62	0	0.07	0.106
811	3.55	0	0.07	0.008
812	2.30	0	0.07	0.059

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
813	1.92	0	0.07	0.021
814	7.10	0	0.07	0.074
815	11.57	0	0.07	0.015
816	2.31	0	0.07	0.104
817	4.75	0	0.07	0.072
818	3.83	0	0.07	0.076
819	0.74	0	0.07	0.010
820	3.15	0	0.07	0.039
821	0.75	0	0.07	0.005
822	4.47	0	0.07	0.062
824	1.24	0	0.07	0.010
825	17.80	0	0.07	0.004
826	2.94	0	0.07	0.014
827	2.01	0	0.07	0.008
828	8.08	0	0.07	0.019
829	12.06	0	0.07	0.015
830	10.24	0	0.07	0.009
831	4.87	0	0.07	0.030
832	2.36	0	0.07	0.039
833	2.38	0	0.07	0.070
834	1.62	0	0.07	0.034
835	2.01	0	0.07	0.045
901	2.16	0	0.07	0.037
902	4.27	0	0.07	0.034
903	0.86	0	0.07	0.031

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
904	15.68	0	0.07	0.028
905	4.65	0	0.07	0.041
906	3.15	0	0.07	0.034
907	0.56	0	0.07	0.006
908	0.42	0	0.07	0.010
909	3.92	0	0.07	0.027
910	2.02	0	0.07	0.005
911	0.34	0	0.07	0.005
912	4.87	0	0.07	0.022
914	0.39	0	0.07	0.004
915	8.00	0	0.07	0.022
916	3.12	0	0.07	0.022
917	5.05	0	0.07	0.006
918	5.11	0	0.07	0.005
919	7.07	0	0.07	0.030
920	2.75	0	0.07	0.007
921	3.07	0	0.07	0.011
922	0.80	0	0.07	0.002
923	3.09	0	0.07	0.007
924	4.33	0	0.07	0.005
925	2.19	0	0.07	0.002
1031	0.72	0	0.07	0.012
1111	0.44	0	0.07	0.021
3091	0.20	0	0.07	0.036
8131	1.06	0	0.07	0.021

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
8211	0.76	0	0.07	0.026

A.5 SPC CATCHMENT

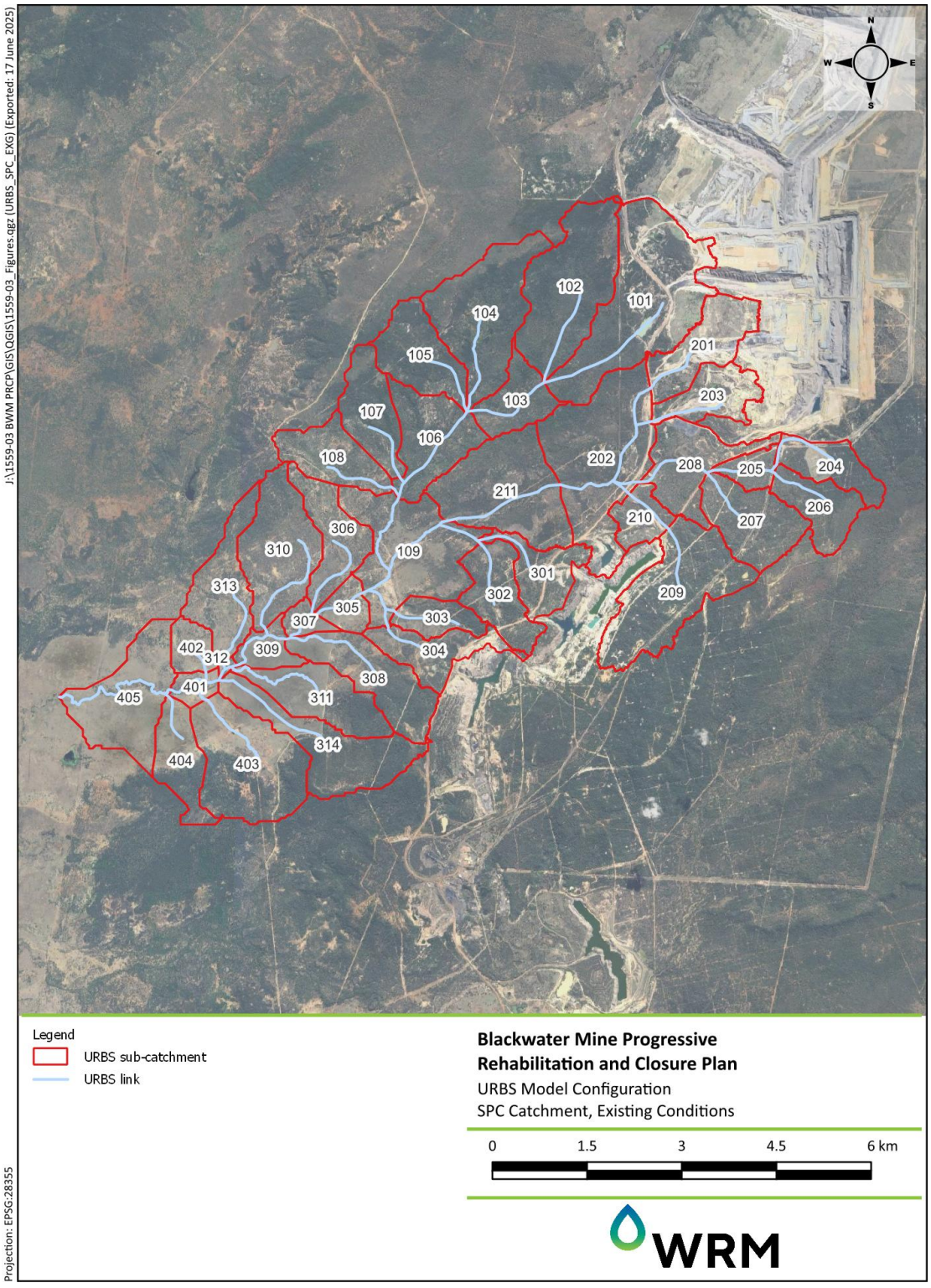


Figure A.5 URBS model configuration of the SPC catchment

Table A.5 URBS catchment parameters of the SPC catchment model

ID	Total Area (km2)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	4.00	0	0.07	0.012
102	2.89	0	0.07	0.018
103	1.00	0	0.07	0.016
104	2.70	0	0.07	0.016
105	1.47	0	0.07	0.028
106	1.69	0	0.07	0.017
107	1.31	0	0.07	0.027
108	1.27	0	0.07	0.027
109	2.90	0	0.07	0.009
201	1.45	0	0.07	0.019
202	3.63	0	0.07	0.007
203	1.05	0	0.07	0.025
204	0.98	0	0.07	0.032
205	0.45	0	0.07	0.029
206	1.07	0	0.07	0.032
207	1.60	0	0.07	0.029
208	1.55	0	0.07	0.011
209	2.80	0	0.07	0.038
210	0.66	0	0.07	0.027
211	2.77	0	0.07	0.011
301	1.06	0	0.07	0.017
302	1.30	0	0.07	0.022
303	0.69	0	0.07	0.024
304	1.12	0	0.07	0.022
305	0.49	0	0.07	0.009

ID	Total Area (km2)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
306	1.32	0	0.07	0.010
307	0.31	0	0.07	0.009
308	1.77	0	0.07	0.019
309	0.53	0	0.07	0.005
310	2.18	0	0.07	0.017
311	1.56	0	0.07	0.015
312	0.07	0	0.07	0.006
313	1.57	0	0.07	0.013
314	2.15	0	0.07	0.012
401	0.33	0	0.07	0.014
402	0.52	0	0.07	0.024
403	2.73	0	0.07	0.019
404	1.13	0	0.07	0.025
405	2.24	0	0.07	0.007

A.6 SRC CATCHMENT

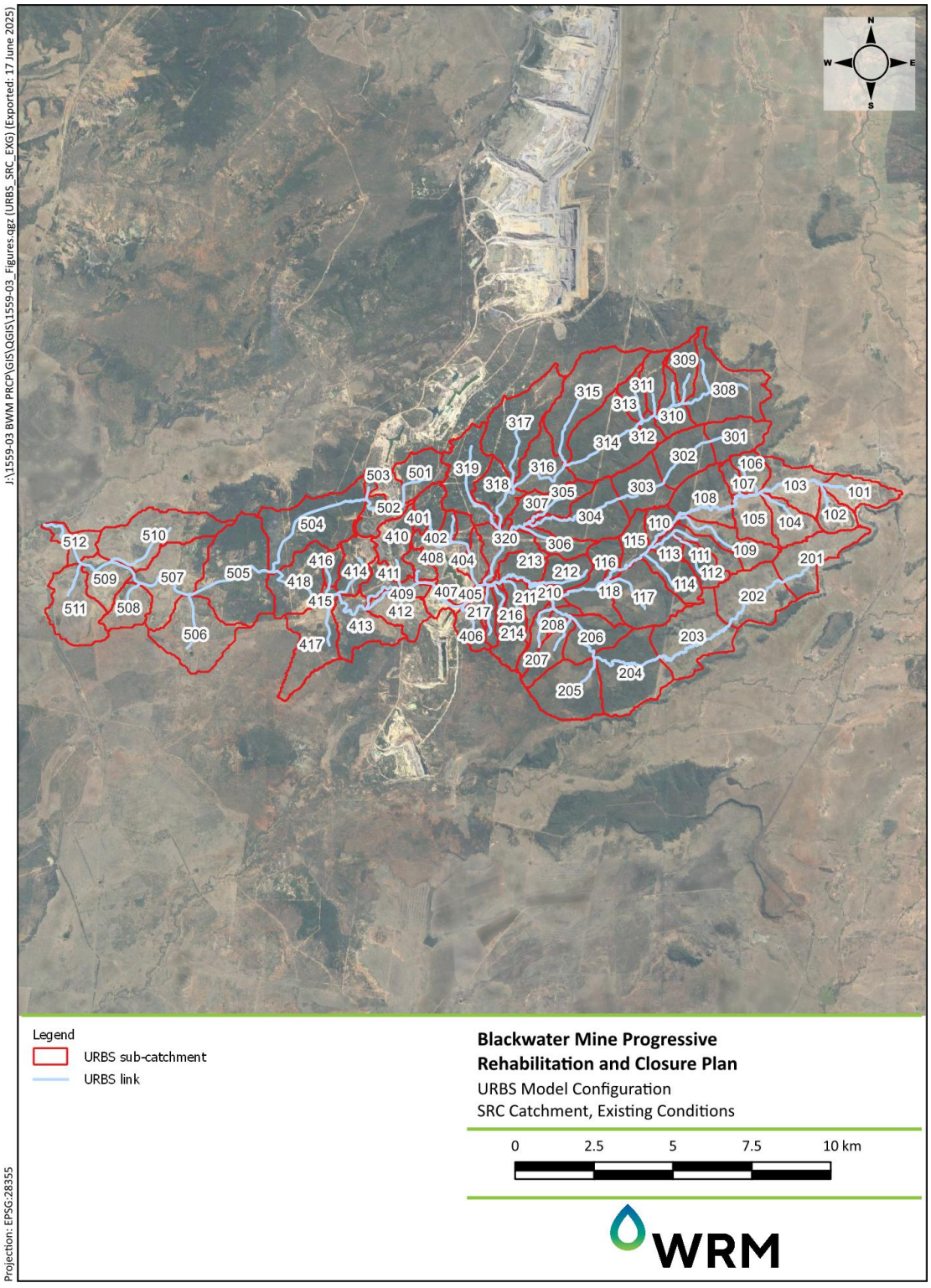


Figure A.6 URBS model configuration of the SRC catchment

Table A.6 URBS catchment parameters of the SRC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.70	0	0.045	0.016
102	1.18	0	0.045	0.016
103	2.37	0	0.045	0.016
104	1.66	0	0.045	0.024
105	1.75	0	0.045	0.027
106	1.13	0	0.045	0.039
107	0.48	0	0.045	0.048
108	2.73	0	0.045	0.019
109	1.92	0	0.045	0.017
110	0.88	0	0.045	0.010
111	1.09	0	0.045	0.022
112	1.22	0	0.045	0.030
113	0.56	0	0.045	0.013
114	1.67	0	0.045	0.025
115	1.17	0	0.045	0.009
116	0.22	0	0.045	0.015
117	3.37	0	0.045	0.025
118	2.75	0	0.045	0.013
201	2.99	0	0.045	0.015
202	3.56	0	0.045	0.010
203	4.26	0	0.045	0.016
204	4.50	0	0.045	0.017
205	3.45	0	0.045	0.022
206	2.04	0	0.045	0.017
207	1.33	0	0.045	0.028

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
208	0.50	0	0.045	0.028
209	0.97	0	0.045	0.031
210	0.21	0	0.045	0.014
211	0.93	0	0.045	0.016
212	1.40	0	0.045	0.020
213	1.11	0	0.045	0.016
214	2.08	0	0.045	0.026
215	0.13	0	0.045	0.005
216	0.40	0	0.045	0.042
217	0.58	0	0.045	0.044
301	2.00	0	0.045	0.015
302	2.56	0	0.045	0.014
303	2.28	0	0.045	0.031
304	3.32	0	0.045	0.011
305	1.21	0	0.045	0.013
306	1.09	0	0.045	0.022
307	0.88	0	0.045	0.015
308	4.36	0	0.045	0.012
309	1.31	0	0.045	0.028
310	1.47	0	0.045	0.024
311	1.18	0	0.045	0.032
312	0.45	0	0.045	0.053
313	0.99	0	0.045	0.033
314	4.85	0	0.045	0.014
315	4.84	0	0.045	0.019

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
316	2.33	0	0.045	0.021
317	4.29	0	0.045	0.018
318	1.76	0	0.045	0.012
319	3.29	0	0.045	0.016
320	1.98	0	0.045	0.008
401	1.30	0	0.045	0.039
402	0.52	0	0.045	0.022
403	0.50	0	0.045	0.023
404	0.91	0	0.045	0.004
405	0.46	0	0.045	0.015
406	1.07	0	0.045	0.044
407	0.73	0	0.045	0.010
408	0.63	0	0.045	0.007
409	0.43	0	0.045	0.017
410	1.99	0	0.045	0.018
411	0.90	0	0.045	0.011
412	1.82	0	0.045	0.010
413	2.61	0	0.045	0.005
414	1.77	0	0.045	0.016
415	0.22	0	0.045	0.032
416	0.59	0	0.045	0.037
417	3.27	0	0.045	0.020
418	2.92	0	0.045	0.021
501	1.80	0	0.045	0.015
502	1.17	0	0.045	0.019

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
503	0.23	0	0.045	0.032
504	5.17	0	0.045	0.012
505	6.15	0	0.045	0.006
506	4.05	0	0.045	0.017
507	3.90	0	0.045	0.007
508	1.60	0	0.045	0.034
509	1.75	0	0.045	0.019
510	4.43	0	0.045	0.008
511	3.38	0	0.045	0.015
512	1.25	0	0.045	0.003

A.7 RLC CATCHMENT

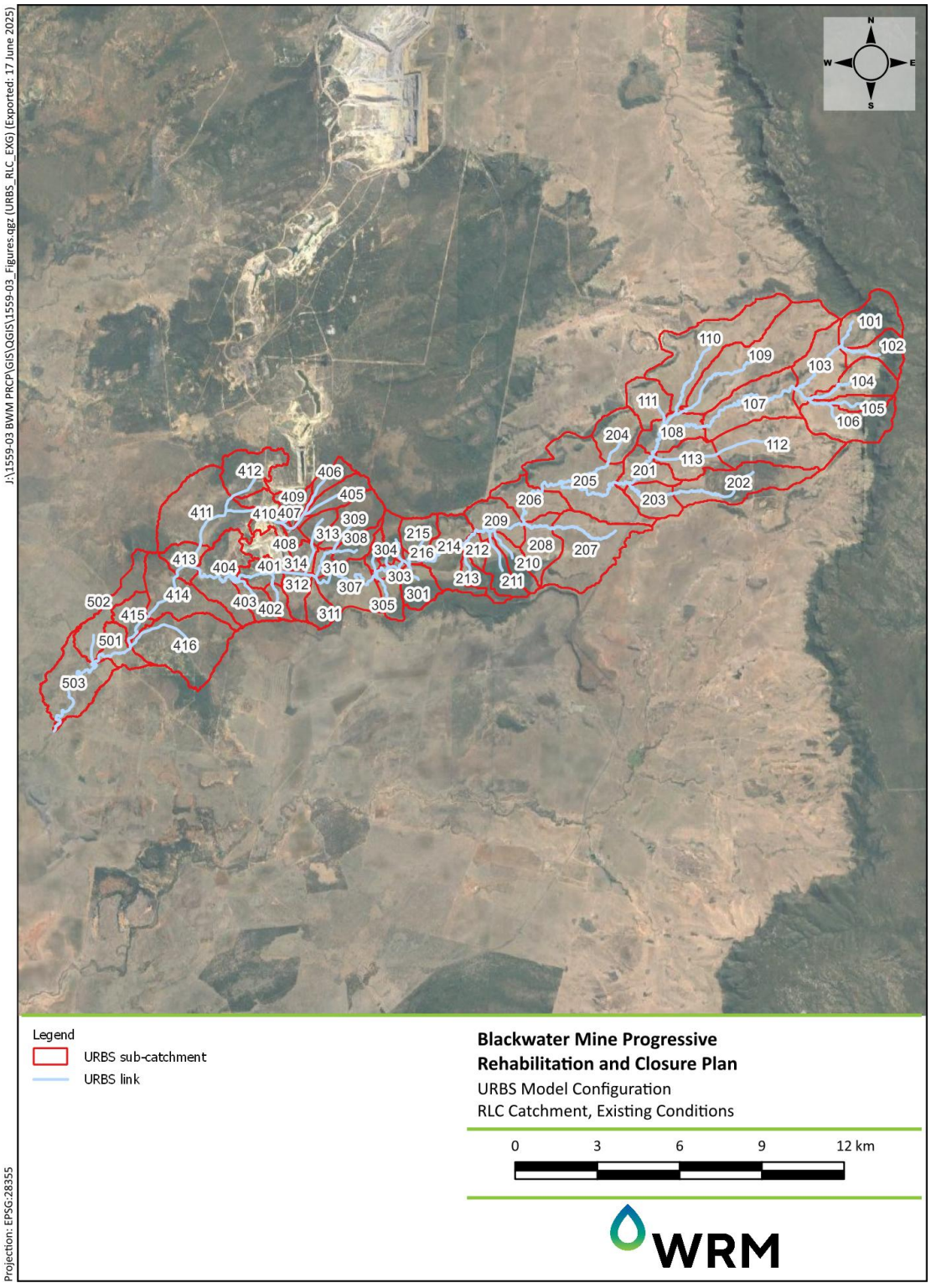


Figure A.7 URBS model configuration of the RLC catchment

Table A.7 URBS catchment parameters of the RLC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	8.50	0	0.07	0.085
102	7.98	0	0.07	0.080
103	7.54	0	0.07	0.075
104	6.86	0	0.07	0.069
105	6.46	0	0.07	0.065
106	6.42	0	0.07	0.064
107	6.24	0	0.07	0.062
108	4.87	0	0.07	0.049
109	4.84	0	0.07	0.048
110	4.63	0	0.07	0.046
111	4.16	0	0.07	0.042
112	4.10	0	0.07	0.041
113	3.77	0	0.07	0.038
201	3.65	0	0.07	0.037
202	3.55	0	0.07	0.036
203	3.29	0	0.07	0.033
204	3.11	0	0.07	0.031
205	2.99	0	0.07	0.030
206	2.96	0	0.07	0.030
207	2.73	0	0.07	0.027
208	2.60	0	0.07	0.026
209	2.57	0	0.07	0.026
210	2.55	0	0.07	0.026
211	2.49	0	0.07	0.025
212	2.48	0	0.07	0.025

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
213	2.46	0	0.07	0.025
214	2.46	0	0.07	0.025
215	2.19	0	0.07	0.022
216	2.00	0	0.07	0.020
301	1.99	0	0.07	0.020
302	1.89	0	0.07	0.019
303	1.82	0	0.07	0.018
304	1.79	0	0.07	0.018
305	1.69	0	0.07	0.017
306	1.67	0	0.07	0.017
307	1.66	0	0.07	0.017
308	1.61	0	0.07	0.016
309	1.56	0	0.07	0.016
310	1.56	0	0.07	0.016
311	1.46	0	0.07	0.015
312	1.37	0	0.07	0.014
313	1.31	0	0.07	0.013
314	1.29	0	0.07	0.013
401	1.29	0	0.07	0.013
402	1.24	0	0.07	0.012
403	1.23	0	0.07	0.012
404	1.16	0	0.07	0.012
405	1.16	0	0.07	0.012
406	1.12	0	0.07	0.011
407	1.07	0	0.07	0.011

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
408	1.05	0	0.07	0.011
409	1.00	0	0.07	0.010
410	0.76	0	0.07	0.008
411	0.75	0	0.07	0.008
412	0.75	0	0.07	0.008
413	0.66	0	0.07	0.007
414	0.60	0	0.07	0.006
415	0.51	0	0.07	0.005
416	0.49	0	0.07	0.005
501	0.29	0	0.07	0.003
502	0.23	0	0.07	0.002
503	0.14	0	0.07	0.001

APPENDIX B CALIBRATION EVENTS

B.1 2017 EVENT

B.1.1 Recorded rainfall

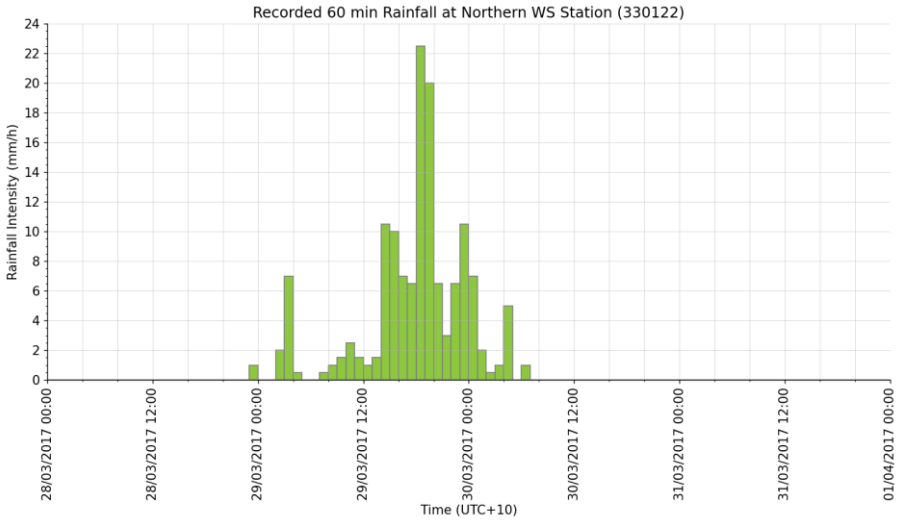


Figure B.1 Recorded rainfall at Northern WS Station (330122), 2017 event

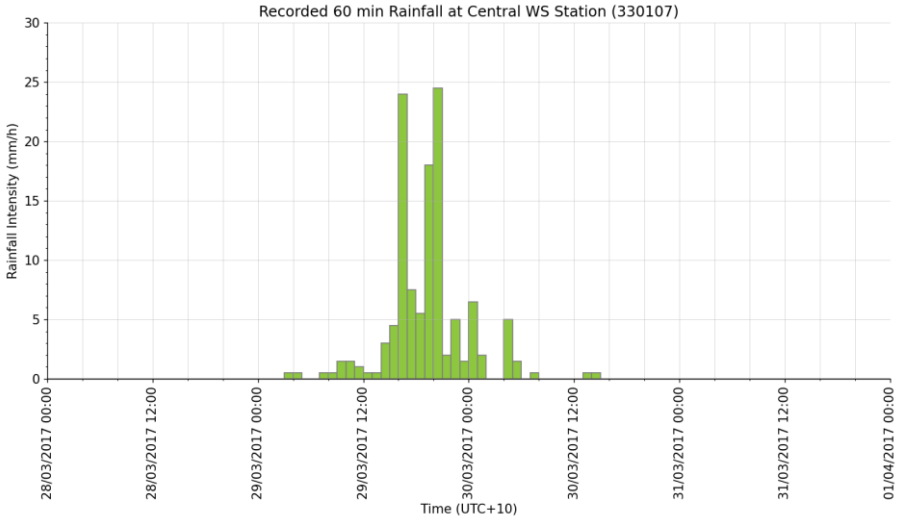


Figure B.2 Recorded rainfall at Central WS Station (330107), 2017 event

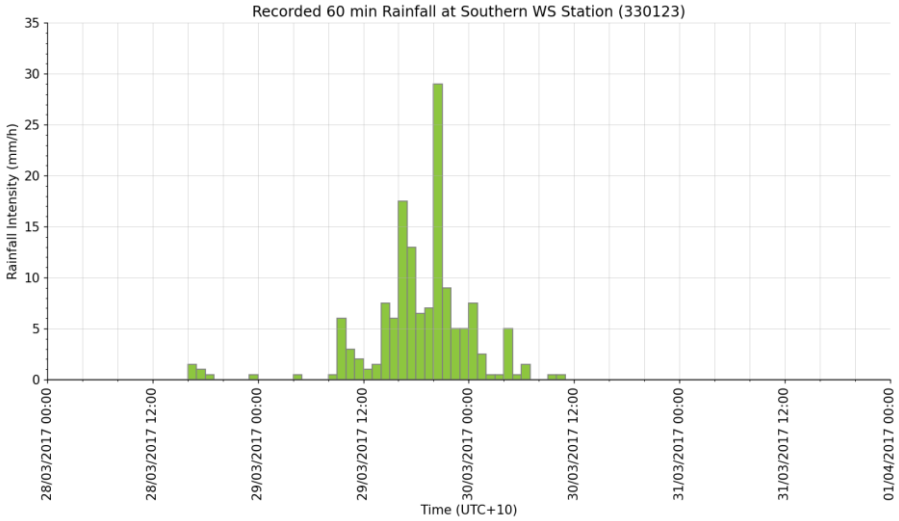


Figure B.3 Recorded rainfall at Southern WS Station (330123), 2017 event

B.1.2 Recorded water levels

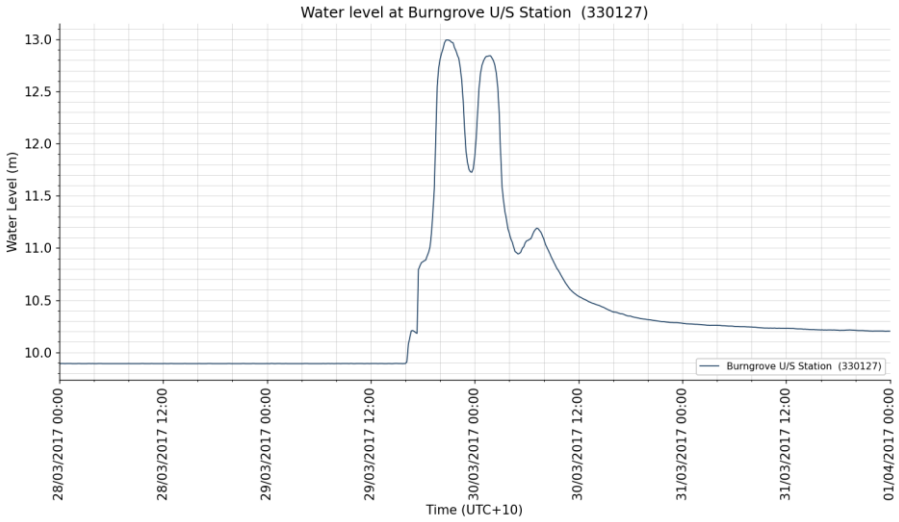


Figure B.4 Recorded water level at Burngrove D/S Station (330117), 2017 event

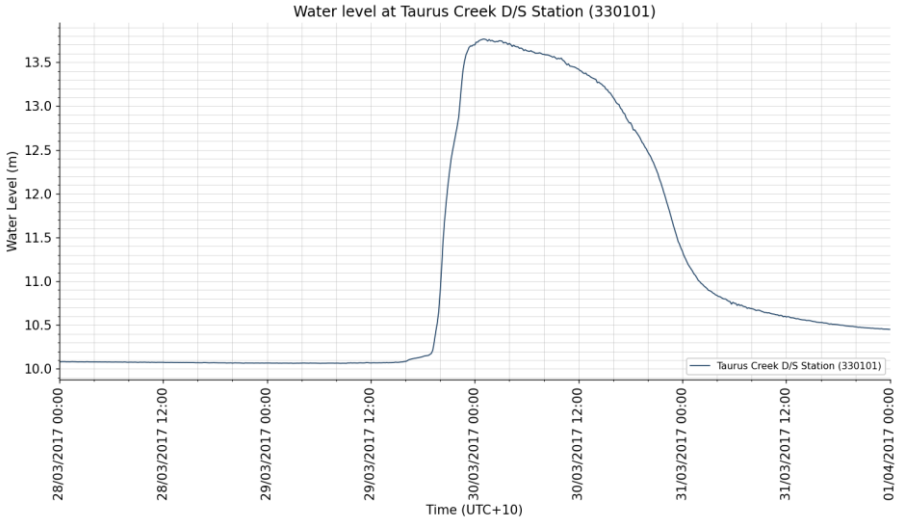


Figure B.5 Recorded water level at Taurus Creek D/S Station (330101), 2017 event

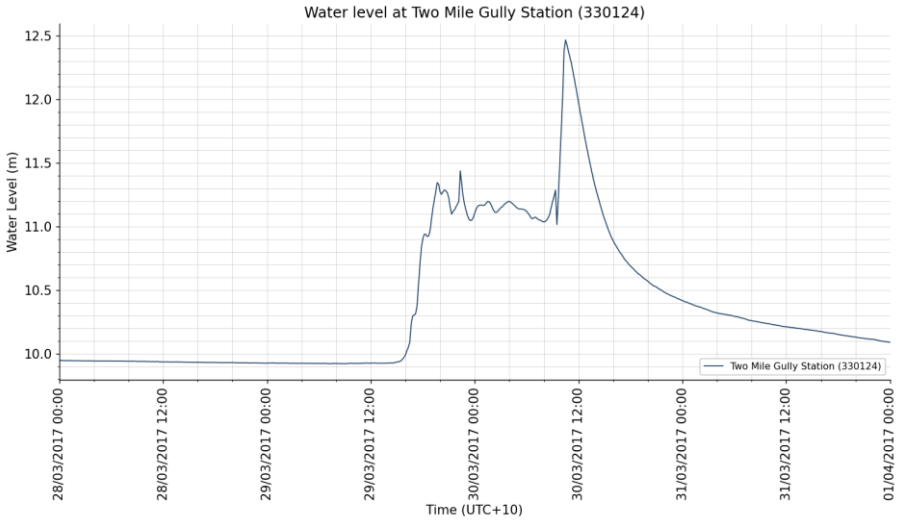


Figure B.6 Recorded water level at Two Mile Gully Station (330124), 2017 event

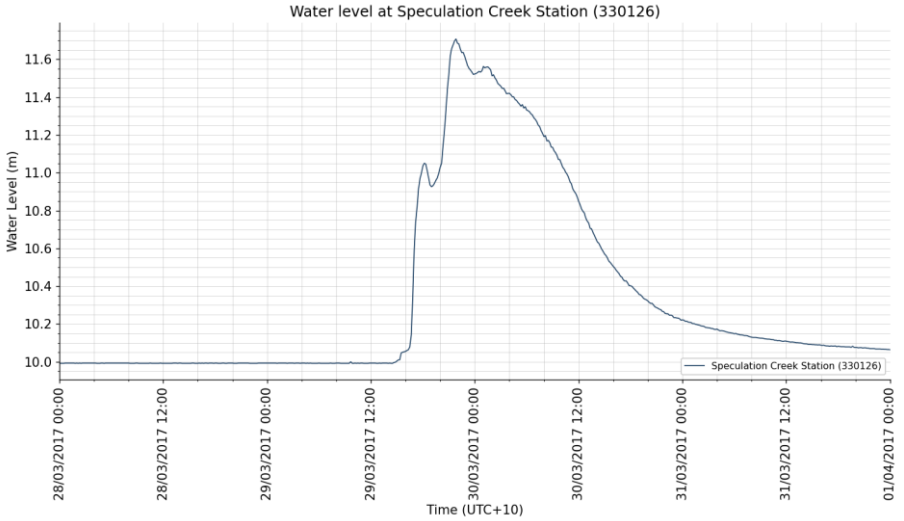


Figure B.7 Recorded water level at Speculation Creek Station (330126), 2017 event

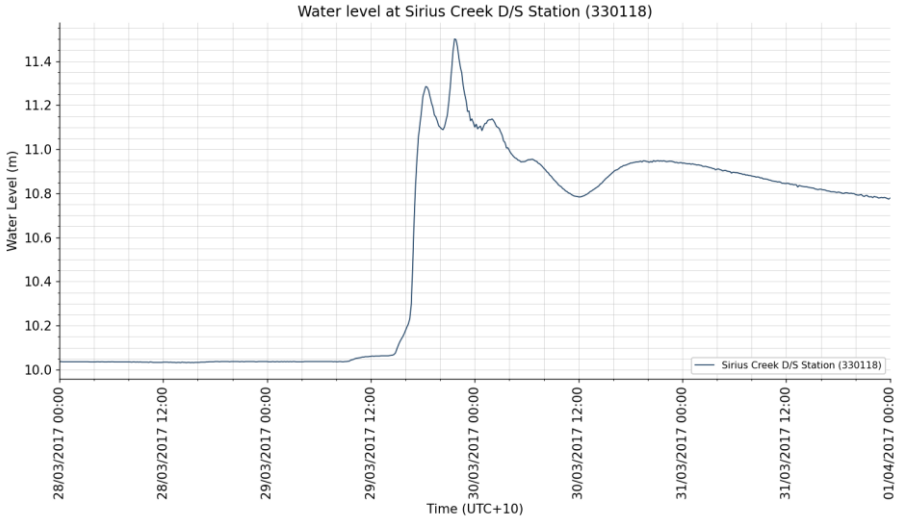


Figure B.8 Recorded water level at Sirius Creek Station (330118), 2017 event

B.2 2020 EVENT

B.2.1 Recorded rainfall

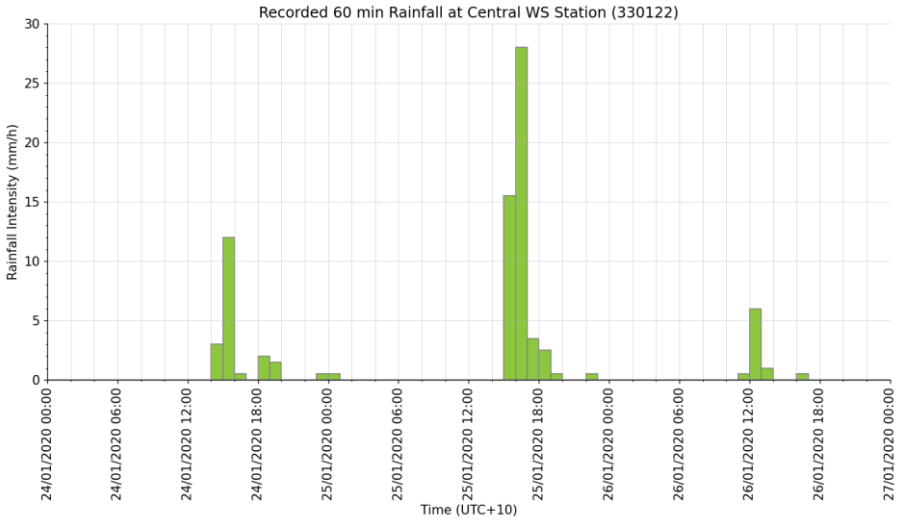


Figure B.9 Recorded rainfall at Northern WS Station (330122), 2020 event

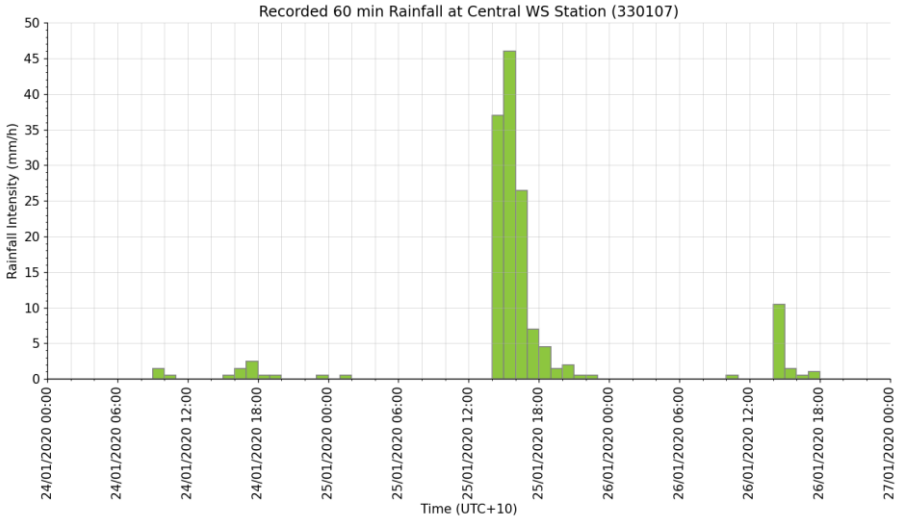


Figure B.10 Recorded rainfall at Central WS Station (330107), 2020 event

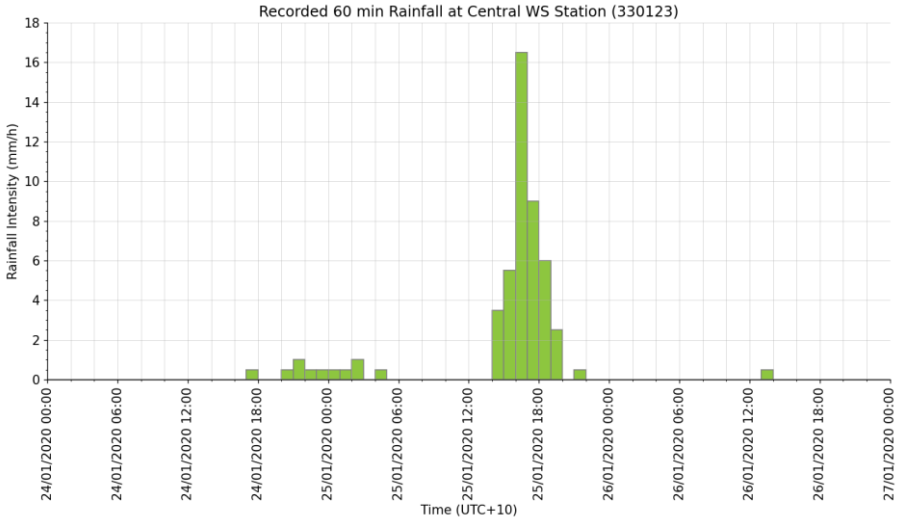


Figure B.11 **Recorded rainfall at Southern WS Station (330123), 2020 event**

B.2.2 Recorded water level

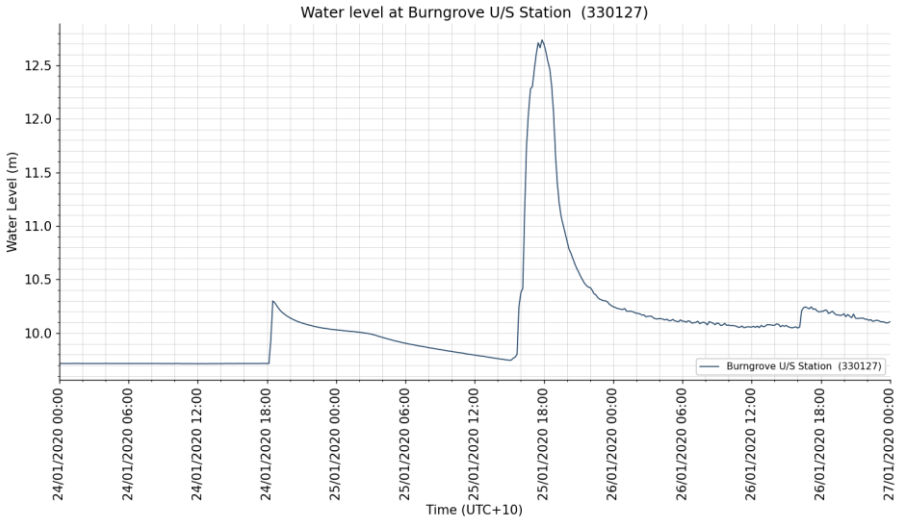


Figure B.12 **Recorded water level at Burngrove U/S Station (330127), 2020 event**

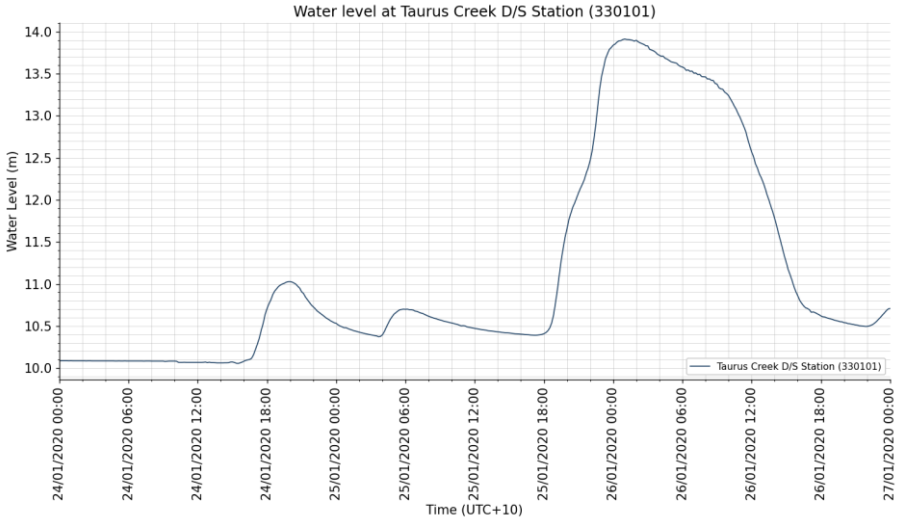


Figure B.13 **Recorded water level at Taurus Creek D/S Station (330101), 2020 event**

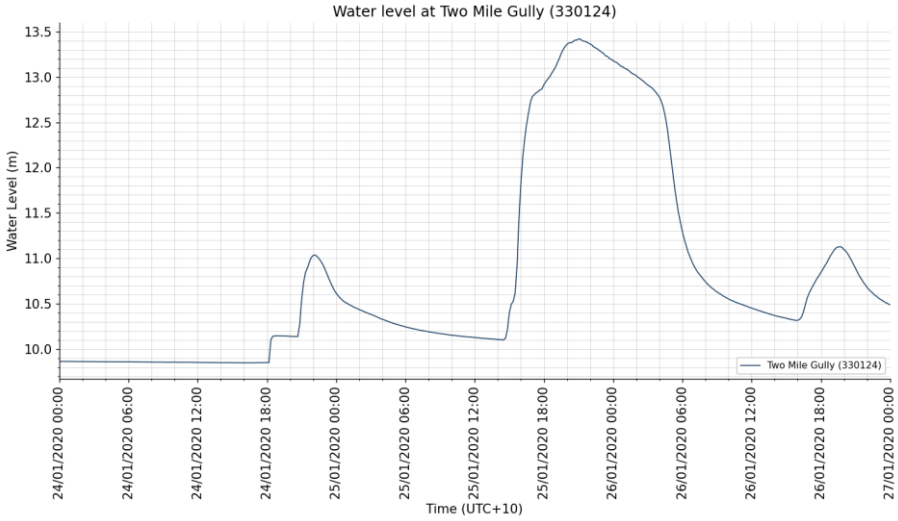


Figure B.14 **Recorded water level at Two Mile Gully Station (330124), 2020 event**

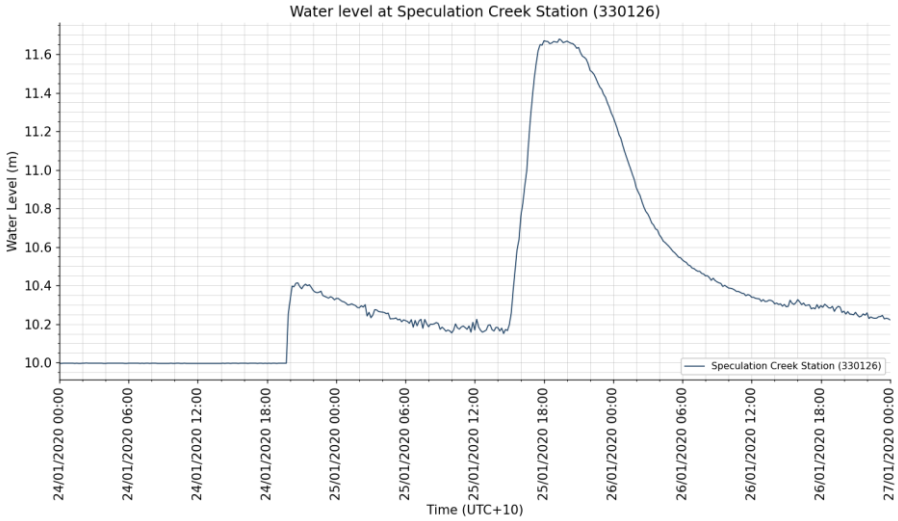


Figure B.15 **Recorded water level at Speculation Creek Station (330126), 2020 event**

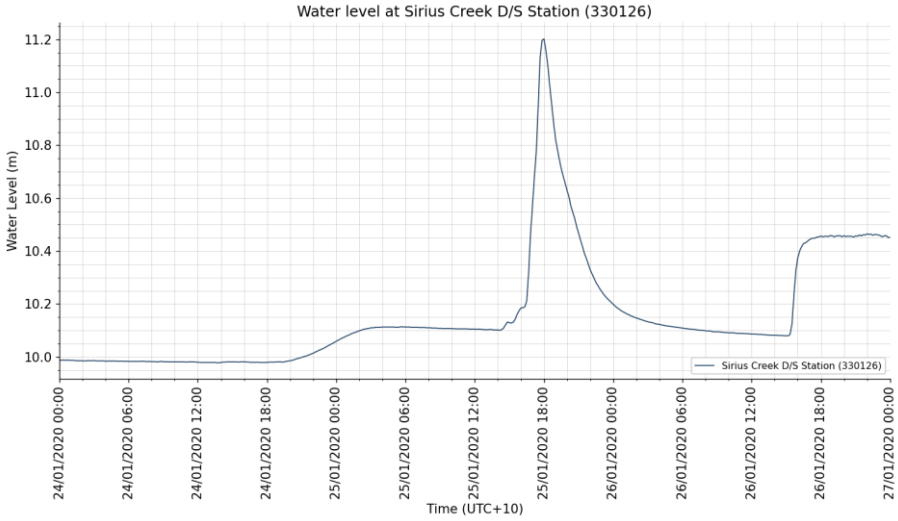


Figure B.16 **Recorded water level at Sirius Creek Station (330118), 2020 event**



Level 1, 369 Ann Street Brisbane
PO Box 10703 Brisbane Adelaide Street Qld 4000
07 3225 0200

Level 5, 93 Mitchell Street Darwin
GPO Box 43348 Casuarina NT 0811
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ABN 96 107 404 544

BLACKWATER MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN

Final Landform Flood Assessment

Whitehaven Coal Limited

28 May 2026

1559-08-F1

DETAILS

Report Title	Blackwater Mine Progressive Rehabilitation and Closure Plan, Final Landform Flood Assessment
Client	Whitehaven Coal Limited

THIS REVISION

Report Number	1559-08-F1
Date	28 May 2026
Author	Lorena Miranda; Trang Nguyen
Reviewer	Ardianto Notodirdjo

NOTE: This report has been prepared on the assumption that all information, data and reports provided to us by our client, on behalf of our client, or by third parties (e.g. government agencies) is complete and accurate and on the basis that such other assumptions we have identified (whether or not those assumptions have been identified in this advice) are correct. You must inform us if any of the assumptions are not complete or accurate. We retain ownership of all copyright in this report. Except where you obtain our prior written consent, this report may only be used by our client for the purpose for which it has been provided by us.

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1 INTRODUCTION

1.1 OVERVIEW

Whitehaven, the owners of Blackwater Mine (BWM), has requested WRM Water & Environment Pty Ltd (WRM) to undertake hydrologic and hydraulic modelling for the BWM final landform, to supplement the BWM Progressive Rehabilitation and Closure Plan (PRCP). BWM requires a PRCP to be completed in accordance with BWM's Environmental Authority (EA) (EPML00717813), and PRCP Guideline Requirements.

The BWM final landform will incorporate 15 final voids as Non-use Management Areas (NUMAs). Figure 1.1 shows the drainage characteristics of the study area under existing (current) conditions as well as the locations and extents of the proposed final voids.

SLR previously prepared the flood assessments for previous version of the BWM final landform (SLR, 2024a and 2024b). In the SLR (2024a and 2024b) studies, hydrologic modelling was undertaken using XP-RAFTS and hydraulic modelling was undertaken using TUFLOW. The SLR (2024a and 2024b) flood models were developed based on the XP-RAFTS and TUFLOW models originally developed by GHD for the 2021 Blackwater Mine Flood Study (GHD, 2021).

This "PRCP Final Landform Flood Modelling" report presents the methodology and results of hydrologic and hydraulic modelling for the following seven catchments, for an updated BWM final landform (post-closure) configuration (refer to Figure 1.1):

- Bonnie Doon Creek (BDC);
- Burngrove Creek (BGC);
- Blackwater Creek (including Taurus Creek and Two Mile Gully) (BWC);
- Sagittarius Creek (SGC);
- Speculation Creek (SPC);
- Sirius Creek (SRC); and
- Rockland Creek (RLC).

The report was prepared to address the requirements in Section 3.6.1 – General rehabilitation practices (flooding) of Department of Environment, Tourism, Science and Innovation (DETSI) (formally the Department of Environment, Science and Innovation) Progressive rehabilitation and closure plans (PRC plans) guideline (Version 3.01) (DETSI, 2024).

1.2 METHOD OF ASSESSMENT

New hydrologic models were developed using the URBS software package, which incorporates the latest climate change guidance from Australian Rainfall and Runoff 2019 Version 4.2 (ARR 2019 v4.2) (Ball et al, 2019). The URBS models were calibrated to recorded rainfall and water level data for the March 2017 and January 2020 events where suitable data is available. Details of the URBS model development and calibration are documented in the Hydrologic Model Development and Calibration Report provided in Appendix D.

The SLR (2024a and 2024b) TUFLOW hydraulic models were updated to incorporate the updated final landform as well as updated design inflows from the new URBS hydrologic models. Hydrologic and hydraulic modelling were undertaken for the 1% (1 in 100) and 0.1% (1 in 1,000) annual exceedance probability (AEP) as well as the Probable Maximum Flood (PMF) events.

A flood risk assessment was then undertaken to assess the risk of flood water ingress into the final voids, as well as the risk of erosion and scour due to floodwater being in contact with rehabilitated landform.

1.3 REPORT STRUCTURE

This report is structured as follows:

- Section 2 describes the drainage characteristics of the study area;
- Section 3 is an overview of the data available for this study;
- Section 4 describes the estimation of design discharges;
- Section 5 presents the hydraulic model development;
- Section 6 presents the hydraulic modelling results including the flood risk assessment;
- Section 7 presents a summary of the findings; and
- Section 8 is a list of references.

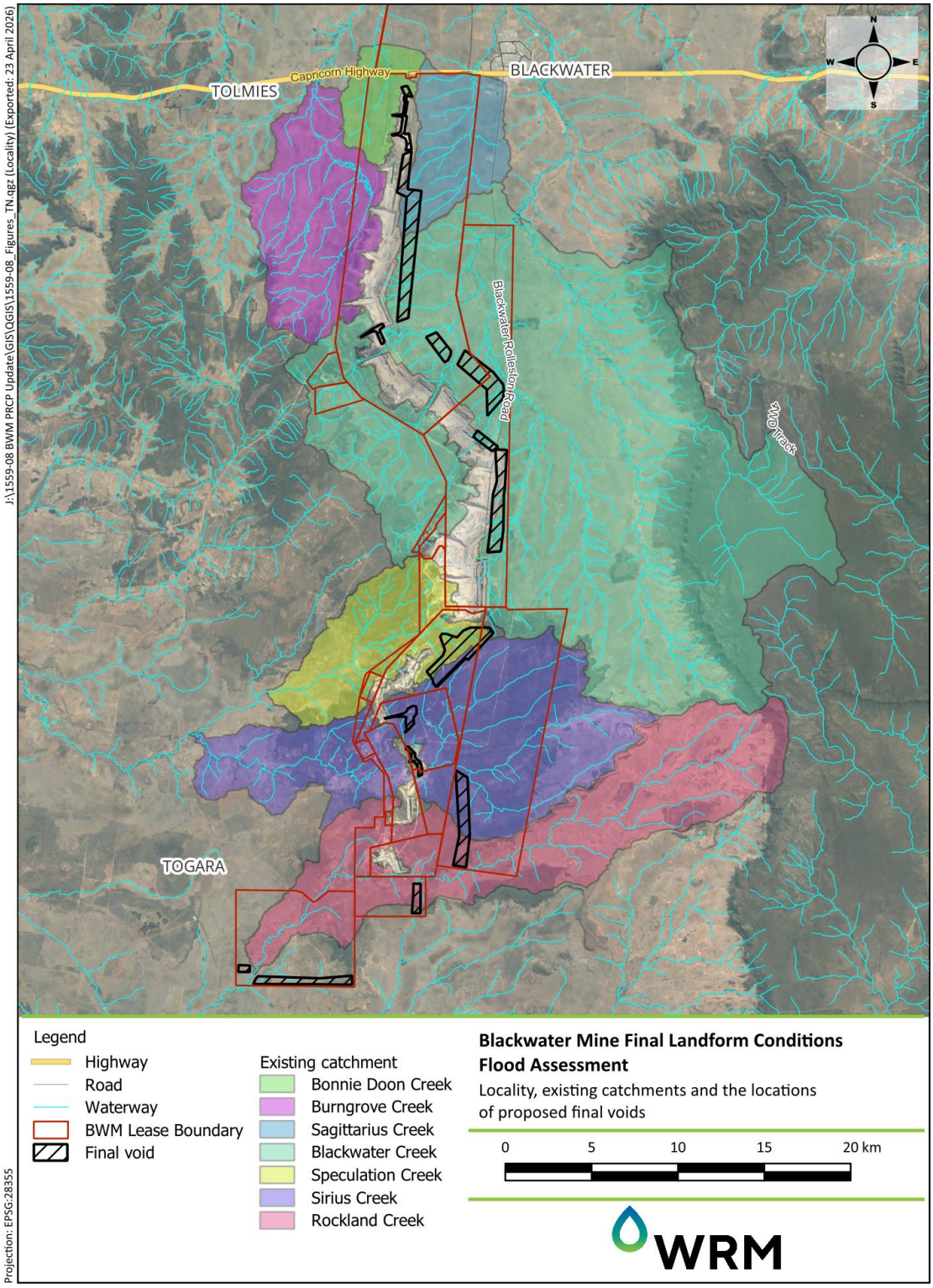


Figure 1.1 Locality, existing catchments and the locations of proposed final voids

2 FINAL LANDFORM CHARACTERISTICS

2.1 FINAL LANDFORM CONFIGURATION

Figure 2.1 shows the final landform configuration including the locations of the proposed final voids. Figure 6.1 to Figure 6.16 show the proposed final landform configuration and the extent of flooding for the 0.1% AEP design flood event.

- The BWM final landform will incorporate the following 15 residual voids:
  - Ramp 8 (R8) Void;
  - Bonnie Doon Void;
  - Mimosa Besgrove Void;
  - Ramp 30 (R30) Void;
  - Deep Creek Void;
  - Stewarton North Void;
  - Stewarton South Void;
  - Tannyfoil Void;
  - South Ballamoo Void;
  - Kenmare Void;
  - Ramp 74 (R74) Void;
  - Togara North Marshmead Void;
  - South Marshmead Void;
  - Comet Downs East Void; and
  - Kennedy Void.
- Temporary flood protection levees (in place during mining to protect the active mining pits from flooding) would be removed such that the rehabilitated out-of-pit overburden areas would prevent floodwater from entering the voids. These components of the final landform are referred to in this report as flood protection landforms.
- A total of 11 of the proposed voids would have flood protection landforms constructed to be at least 50 m wide at the crest, and with crest heights above the adjacent 0.1% AEP peak flood level.
- The remaining three voids (R8, Bonnie Doon, Stewarton South and Kenmare) would be located away from any major watercourses and outside of the floodplain of these watercourses.
- It is assumed that the final landform, including sections with potential to interact with floodwaters, would be rehabilitated to achieve the minimum groundcover requirements of rehabilitation milestone (RM) 6.3 of the PRCP schedule for BWM (the PRCP Schedule) (DETSI, 2026).

2.2 DRAINAGE CHARACTERISTICS

Figure 2.1 shows the drainage characteristics in the vicinity of BWM under final landform conditions, which are described as follows:

- Bonnie Doon Creek (BGC) drains in a northerly direction west of the BWM final landform.
- Sagittarius Creek (SGC) drains in a northerly direction east of the BWM final landform.
- The Burngrove Creek (BGC) catchment comprises the following three streams:

- Burngrove Creek, flows in a northeasterly direction west of the BWM final landform. A 3 km section of the natural Burngrove Creek channel was removed by the BWM operations and replaced by a diversion channel (licensed diversion reference 40137F) that drains north between the railway and the BWM. For this assessment, it is assumed that this diversion will remain under final landform conditions.
- Cabbagetree Creek originates from the southwest of the catchment and drains in a northeasterly direction west of the BWM final landform before joining Burngrove Creek.
- Tolmies Creek originates from the west of the catchment and drains in a northeasterly direction west of the BWM final landform before joining Burngrove Creek.

- The Blackwater Creek (BGC) catchment comprises the following five streams:
  - Blackwater Creek originates from the south of the catchment and flows in a northern direction. This creek does drain through the BWM mine lease.
  - Taurus Creek, a major tributary of Blackwater Creek, originates from the east of BWM and drains in a northeasterly direction downstream of the Emu Creek Diversion in between rehabilitated dumps, and then between the Deep Creek and Stewarton North voids, eventually joining Blackwater Creek about 6 km east of the BWM final landform.
  - Emu Creek, a tributary of Taurus Creek, originates from the west (upstream) of BWM and flows in a northeasterly direction. It is then diverted in a northwesterly direction via the Emu Creek Diversion, which drains to Taurus Creek just upstream (west) of the BWM final landform.
  - Deep Creek, a tributary of Taurus Creek, originates from the west of BWM and drains in a northeasterly direction via the Deep Creek temporary diversion in between rehabilitated dumps, and between the R30 and Deep Creek voids, before joining Taurus Creek about 3 km east of BWM final landform.

    A conceptual design of a permanent Deep Creek Diversion is currently being developed, but it has not been incorporated into the final landform assessed in this study.
  - Two Mile Gully, a tributary of Taurus Creek, flows in a northerly direction east of the BWM final landform and joins Taurus Creek about 5 km east of the Mimosa Besgrove void.
- Speculation Creek (SPC) originates from the western extents of BWM and flows in a southwesterly direction away from BWM. Runoff from rehabilitated dumps of the BWM final landform will drain west to the upper reaches of the Speculation Creek and its minor tributaries.
- Sirius Creek originates from the east (upstream) of BWM. It flows in a westerly direction through BWM via the Sirius Creek temporary diversion (licensed diversion reference 52652F), which drains around the southern side of the R74 void. Downstream of the Sirius Creek temporary diversion, Sirius Creek continues to drain in a westerly direction away from the BWM final landform.

  A conceptual design of a permanent Sirius Creek Diversion is currently being developed, but it has not been incorporated into the final landform assessed in this study.
- Rockland Creek originates from the east (upstream) of the BWM. It flows in a westerly direction adjacent to the South Marshmead void. Further downstream Rockland Creek then drains southwest adjacent to rehabilitated dumps and between the Comet Downs East and Kennedy voids. Rockland Dam, which currently exists within the BWM mine lease, will be decommissioned for the final landform.

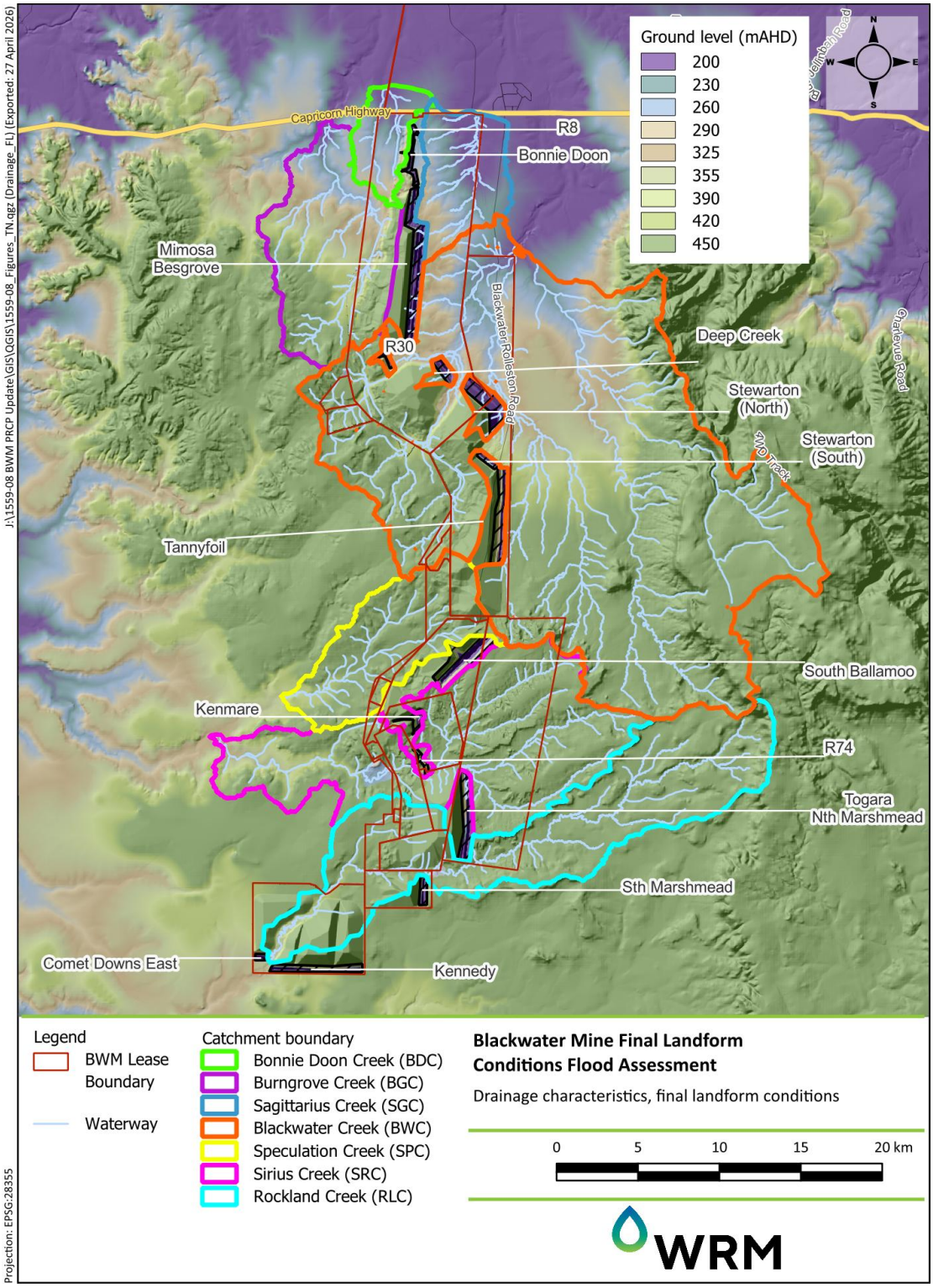


Figure 2.1 Final landform configuration and drainage characteristics

3 AVAILABLE DATA

3.1 OVERVIEW

Available data for this study was provided by Whitehaven and consisted of:

- Previous hydrologic and hydraulic studies;
- Recorded rainfall and water level data;
- LiDAR topographic data; and
- Proposed final landform surface.

3.2 PREVIOUS STUDIES

3.2.1 Blackwater Mine Flood Study (2021)

The Blackwater Mine Flood Study undertaken by GHD (2021) assessed existing flood risks across BWM. XP-RAFTS hydrologic and TUFLOW hydraulic models were developed for this study. In this study, the hydrologic models for Burngrove Creek and Speculation Creek were calibrated to recorded water level data. The GHD (2021) study report was provided for this study, but the XP-RAFTS and TUFLOW models were not available.

3.2.2 Blackwater Mine Progressive Rehabilitation and Closure Plan (2024)

The XP-RAFTS hydrologic and TUFLOW hydraulic models used by SLR (2024a and 2024b) for the previous PRCP flood assessment were provided for this study. These models appear to have been developed based on the GHD (2021) hydrologic and hydraulic models. Separate models were provided for the following catchments:

- Bonnie Doon Creek;
- Blackwater Creek;
- Burngrove Creek;
- Rockland Creek;
- Sagittarius Creek;
- Sirius Creek;
- Speculation Creek;
- Taurus Creek; and
- Two Mile Gully.

3.3 TOPOGRAPHIC DATA

The available topographic data used for this study is described as follows:

- A 1 m resolution LiDAR covering the BWM mine lease area captured in February 2024 (referred to as the 2024 LiDAR data);
- A 1 m resolution LiDAR covering the active mining pits of BWM captured in February 2025 (referred to as the 2025 LiDAR data);
- Topographic data embedded in the SLR (2024) TUFLOW hydraulic models;

- A 30 m resolution Copernicus Digital Surface Model (DSM) satellite ground level observation data obtained from the European Space Programme on 31 January 2025 (referred to as the Copernicus DSM data); and
- Proposed final landform design surface "20251104 BWM PRCP Rev3 LF4.2 1x1m grid" (Rev3 final landform) provided in November 2025.

3.4 RAINFALL AND WATER LEVEL DATA

Whitehaven supplied recorded rainfall data from three subdaily rainfall (pluviograph) stations and recorded water level data for six stream gauging stations across BWM. Rating curves were also provided for the stream gauging stations. The data was used to calibrate the URBS hydrologic models. Details of the station locations, the recorded data and the stream gauge rating curves are described in the Hydrologic Model Development Report in Appendix D.

4 ESTIMATION OF DESIGN DISCHARGES

4.1 OVERVIEW

4.1.1 Development and calibration of seven URBS hydrologic models

A total of seven URBS hydrologic models were developed for the following catchments:

- Bonnie Doon Creek;
- Blackwater Creek (including Taurus Creek and Two Mile Gully);
- Burngrove Creek;
- Rockland Creek;
- Sagittarius Creek;
- Sirius Creek;
- Speculation Creek.

The Burngrove Creek, Blackwater Creek (including Taurus Creek and Two Mile Gully) and Sirius Creek URBS models were calibrated to recorded data for the April 2017 and January 2020 flood events. The remaining four models could not be calibrated due to limitations of the available topographic data and rating curves.

Design discharges for the 1% AEP event from the seven URBS models were validated against estimates derived using the Rational Method, the Quantile Regression Technique (QRT) and the Regional Flood Frequency Estimation (RFFE) method. The purpose of the model validation is to derive appropriate initial losses (ILs) and continuing losses (CLs) for the seven models.

The hydrologic model development, calibration and validation are described in detail in the "Hydrologic Model Development and Calibration Report" given in Appendix D. The estimation of validation of design discharges were undertaken based on current (year 2025) catchment and climate conditions.

4.1.2 Modification of URBS hydrologic models for final landform conditions

For the final landform flood assessment, the calibrated and validated URBS models were modified to reflect catchment and climate conditions for the final landform. That is, the URBS model subcatchment boundaries were adjusted to reflect the final landform, and the design rainfalls were adjusted to reflect future climate conditions incorporating impacts of climate change for the year 2100, when the final landform expected to be in established.

The modified hydrologic models were then used to derive design discharges for the 1% AEP, 0.1% AEP and PMF design flood events for the proposed final landform conditions. Details on the hydrologic model updates and results are described below.

4.2 HYDROLOGIC MODEL CONFIGURATION

4.2.1 Subcatchment parameters

The boundaries of the URBS subcatchments were adjusted to represent the proposed final landform conditions. Figure A.1 to Figure A.7 in Appendix A shows the modified URBS model subcatchments configuration reflecting final landform conditions. The URBS model parameters were updated as necessary to reflect the =the catchment area, slope, imperviousness, and PERN. A summary of the final landform URBS model parameters is given in Table A.1 to Table A.7 in Appendix A.

4.2.2 Adopted global URBS model parameters

The global URBS model parameters, including channel lag parameter (alpha), catchment storage parameter (beta), catchment non-linearity (M) and channel routing exponent (N) for all seven hydrologic models are given below and were unchanged from the calibrated/validated hydrologic models.

- Channel routing "alpha" (α) = 0.1
- Catchment routing "beta" (β) = 1.0
- Catchment routing exponent (M) = 0.715
- Channel routing exponent (N) = 1.0

4.3 DESIGN RAINFALLS

4.3.1 Design rainfall depths

Design rainfall intensity-frequency-duration (IFDs) for the 1% and 0.1% AEP events were obtained from the Bureau of Meteorology (BoM).

For the Probable Maximum Precipitation (PMP) event, rainfall depths were estimated using the methodologies given in:

- *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method* (GSDM) (BoM, 2003) for durations up to 6 hours; and
- *Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method* (GTSMR) (BoM, 2005) for durations 24 hours and longer.

Design rainfalls for durations between 6 and 24 hours were interpolated.

Aerial Reduction Factors (ARFs) were applied to the design rainfalls for each model based on a focal point at the location of the proposed voids in each catchment.

4.3.2 Temporal patterns

The ARR datahub[1] rare bin temporal patterns were adopted for the 1% AEP event. For the 0.1% AEP and PMP design events:

- The Jordan (2005) temporal patterns were adopted for durations up to 9 hours; and
- The GTSMR historical temporal patterns were adopted for durations longer than 9 hours.

Using the above approach, the 1%, 0.1% and PMF design events were modelled using the ensemble approach as recommended by ARR 2019.

4.3.3 Adjustment for climate change

Design rainfall IFDs were scaled up using uplift factors obtained from ARR datahub[2], corresponding to the SSP2-4.5 (year 2100) climate scenario. The associated pre-burst rainfalls were also scaled up accordingly.

Intensity-Frequency-Duration (IFD) design rainfalls and pre-burst estimates were uplifted in consistency with the SSP2-4.5 (year 2100) scaling factors provided by ARR datahub.

[1] https://data.arr-software.org/

[2] https://data.arr-software.org/

The SSP2-4.5 climate adjustments account for approximately 2.4°C of predicted global warming for the long term (2081-2100) since the historical baseline period of 1961-1990. Table 4.1 shows the corresponding design rainfall uplift factors for various storm durations (as percentage increases compared to the baseline IFD data).

Table 4.1 Adopted design rainfall uplift factors (SSP2-4.5 year 2100)

Storm duration	Rainfall uplift factor
<1 hour	41%
1.5 Hours	37%
2 Hours	35%
3 Hours	32%
4.5 Hours	29%
6 Hours	27%
9 Hours	25%
12 Hours	24%
18 Hours	22%
>24 Hours	21%

4.3.4 Losses

For the 1% AEP event, the validated initial (IL) and continuing (CL) losses were adopted and are shown in Table 4.2 (and in Appendix D). For the 0.1% AEP and PMF events, a conservative approach was adopted by adopting an IL of 0 mm and CL of 1 mm/h.

Table 4.2 Adopted design event initial (IL) and continuing (CL) losses for the 1% AEP event

URBS Model	1% AEP losses	
	IL (mm)	CL (mm/h)
Bonnie Doon Creek (BDC)	5	3.5
Burngrove Creek (BGC)	35	3.5
Sagittarius Creek (SGC)	0	2.0
Blackwater Creek (BWC)	0	3.5
Speculation Creek (SPC)	0	3.5
Sirius Creek (SRC)	50	3.5
Rockland Creek (RLC)	0	2.0

4.4 DESIGN PEAK DISCHARGES

Table 4.3 shows the URBS model-predicted design peak discharge, critical storm durations and representative temporal patterns for the 1% AEP, 0.1% AEP and PMF events for final landform conditions at key reporting locations (shown in Figure 4.1). The representative temporal patterns for the critical durations were selected based on the temporal pattern that produces a peak discharge slightly above the mean of the 10 temporal patterns for the critical duration.

Table 4.3 URBS model predicted design peak discharges and critical durations

Model	Location	Design Event								
		1% AEP			0.1% AEP			PMP		
		Critical Duration (h)	TP	Flow (m^3/s)	Critical Duration (h)	TP	Flow (m^3/s)	Critical Duration (h)	TP	Flow (m^3/s)
BDC	BDC_01	1	3	74	1	7	119	1	7	486
BGC	BGC_01	2	8	373	1.5	9	735	1.5	9	2,883
BWC	BWC_01	2	8	245	2	4	389	1.5	4	1,633
	BWC_02	2	8	209	3	7	341	2	4	1,590
	BWC_03	2	1	863	2	4	1,361	2	2	6,219
	TR2M	6	6	1,142	6	7	1,905	4.5	1	7,659
RLC	RLC_02	4.5	3	570	6	9	947	4.5	9	3,677
	RLC_03	6	1	595	6	9	974	4.5	9	3,715
	RLC_04	6	1	767	9	8	1,201	6	6	4,365
	RLC_Out	6	1	767	9	8	1,222	6	6	4,349
SGC	SGC_01	4.5	3	165	3	7	267	2	4	1,302
SRC	SRC_02	6	8	413	1.5	4	878	1	9	3,622
	SRC_03	6	8	808	2	4	1,704	2	9	7,254
SPC	SPC_01	2	8	108	2	7	171	1	4	738

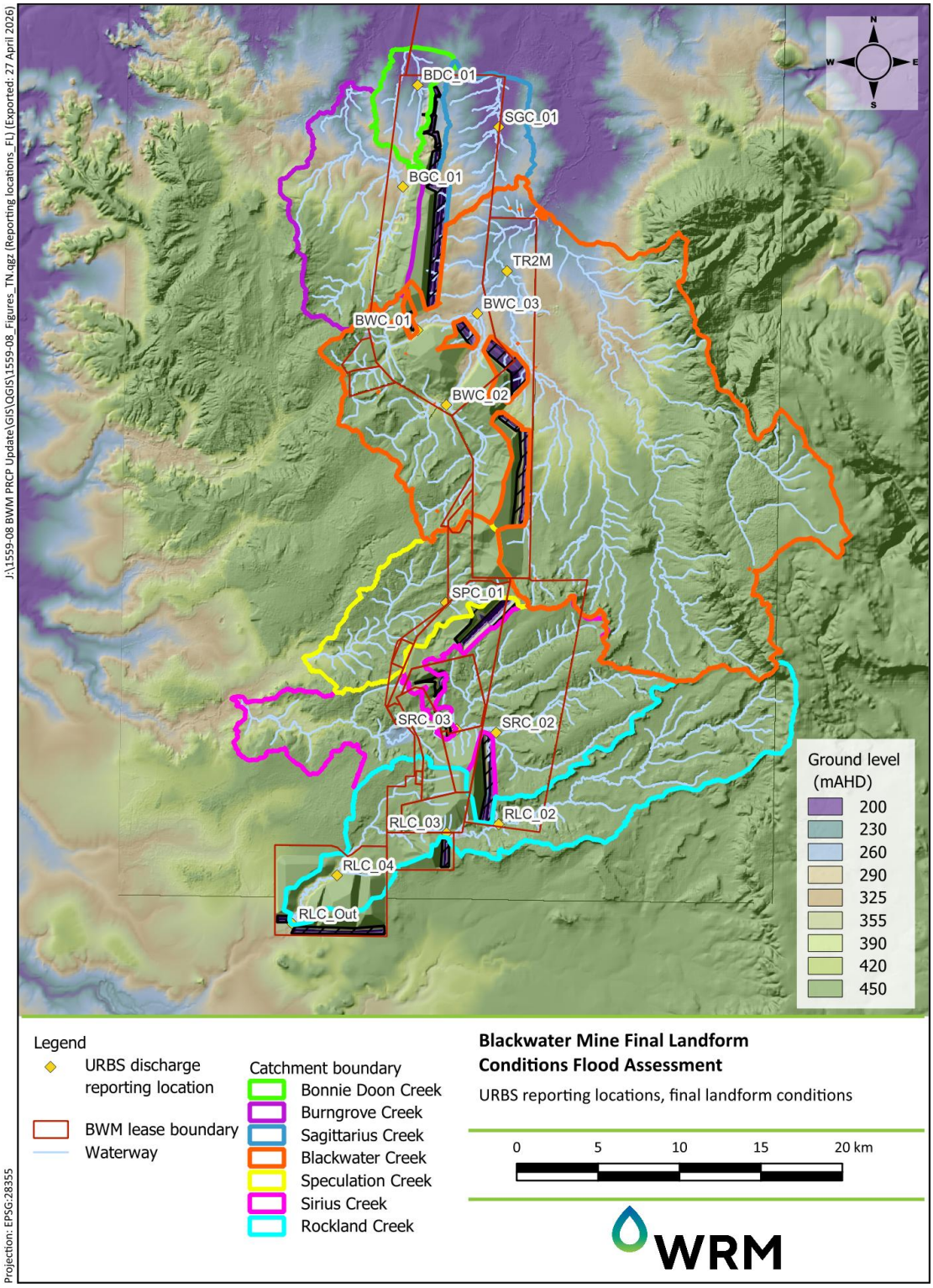


Figure 4.1 URBS discharge reporting locations

5 HYDRAULIC MODEL DEVELOPMENT

5.1 OVERVIEW

The seven (7) TUFLOW hydraulic models originally developed by SLR (2024b) were updated to incorporate the updated final landform and revised design discharges from the new URBS hydrologic models.

The updated hydraulic models were used to estimate design flood levels, depths, extents and velocities under final landform conditions, for the 1% AEP, 0.1% AEP and PMF design flood events for a subset of critical durations and temporal patterns selected based on hydrologic model results as well as preliminary hydraulic modelling results.

5.2 MODEL DEVELOPMENT

5.2.1 Model extent, resolution and topography

All seven TUFLOW models were configured with a 5 m grid cell size. Figure B.1 to Figure B.7 in Appendix B show the configuration and extent of the TUFLOW model models for this study.

The TUFLOW topography was configured as follows:

- The one metre resolution design final landform surface was used to represent the final landform and it supersedes all other topographic data across the mine lease area.
- The one metre resolution LiDAR data (dated 2024 and 2025) provided by Whitehaven was used in areas outside of the final landform within the BWM mine lease.
- A 30 m resolution Copernicus DEM was used over areas that were not covered by the one metre resolution DEM.

TUFLOW ‘z-shapes’ were used to improve the representation of roads and drainage features across the study area.

5.2.2 Boundary conditions

Design discharge hydrographs estimated using the URBS models were applied at the inflow boundary locations for the range of design events. Figure B.1 to Figure B.7 in A.6 show the location of inflow and outflow boundaries in the TUFLOW models. The inflow boundaries included in the models are as follows:

- Bonnie Doon Creek (BDC):
  - A total of 14 local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - Two ‘stage-discharge’ (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 1.3% and 0.7%;
- Burngrove Creek (BGC):
  - A total of 30 local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - Three total inflow boundary representing total inflows from URBS subcatchments outside of hydraulic model boundary;
  - One ‘stage-discharge’ (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 1.2%;
- Blackwater Creek (including Taurus Creek, Deep Creek and Two Mile Gully) (BWC):

- A total of 132 local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
- Three total inflow boundary representing total inflows from URBS subcatchments outside of hydraulic model boundary;
- One 'stage-discharge' (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 0.13%;

- Sagittarius Creek (SGC):
  - A total of 28 local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - One 'stage-discharge' (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 0.12%;
- Speculation Creek (SPC):
  - A total of Twenty-eight (28) local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - One (1) total inflow boundary representing total inflows from URBS subcatchments outside of hydraulic model boundary;
  - one (1) 'stage-discharge' (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 0.53%;
- Sirius Creek (SRC):
  - A total of 33 local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - Four total inflow boundary representing total inflows from URBS subcatchments outside of hydraulic model boundary;
  - One 'stage-discharge' (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 0.53%;
- Rockland Creek (RLC):
  - A total of 23 local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - Two total inflow boundary representing total inflows from URBS subcatchments outside of hydraulic model boundary;
  - One 'stage-discharge' (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 0.5%;

5.2.3 Hydraulic roughness

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance (notionally channel or floodplain roughness). Discrete regions of continuous vegetation types and land uses were mapped, and appropriate roughness values assigned to each region. Vegetation and land use mapping was undertaken using an aerial photograph. Table 5.1 shows the adopted Manning's 'n' values based on typical published values (Chow, 1959). The adopted hydraulic roughness coefficients for each surface type were unchanged from the SLR (2024b) study, but the hydraulic roughness mapping was updated slightly to reflect the updated final landform.

Table 5.1 Adopted hydraulic roughness coefficients

Surface type	Adopted Manning's 'n'
Short grass	0.04
Bare land	0.03
Sparse trees	0.06
Dense trees	0.08
Creek channel	0.05
Paved Roads	0.02
Rail embankment	0.03
Rehabilitated landform	0.04
Water surfaces	0.02

5.2.4 Hydraulic structures

1. The following approach was adopted for the configuration of hydraulic structures (i.e. culverts and bridges) in the TUFLOW hydraulic models:

- It was assumed that all hydraulic structures within the BWM mine lease area (i.e. Whitehaven assets) will be decommissioned post-closure.
- Hydraulic structures located along third-party infrastructure are assumed to remain post-closure. These third-party infrastructures include:
  - Existing access road west of the BWM mining area;
  - Existing railway line to the west of the BWM mining area; and
  - Blackwater Rolleston Road and Taurus Road to the east of the BWM mining area.

2. Out of the seven TUFLOW models developed for this study, three (BDC, BGC and BWC) include culverts and/or bridges along third party infrastructure that will remain post-closure. The remaining four models do not include culverts and/or bridges.
3. Details of the culverts included in the BDC, BGC and BWC models are provided in the Table B.1 to B.7 in Appendix B.

6 FINAL LANDFORM CONDITIONS FLOODING

6.1 OVERVIEW

Hydraulic modelling was undertaken for the 1% AEP, 0.1% AEP and PMF design flood events under proposed final landform conditions, and for the SSP2-4.5 (year 2100) future climate scenario.

Flood maps showing flood depths, levels, extents and velocities are shown in the following sections for the 0.1% (1 in 1,000) AEP event. The corresponding flood maps for the 1% AEP and PMF events are provided in Appendix C.

A summary of the model results for each catchment are presented in the following sections, focusing on the flood immunity of the proposed voids, the risk of erosion and scour in the vicinity of the proposed final voids as well as potential alterations in flow compared to existing conditions.

6.2 ADOPTED CRITERIA TO ASSESS COMPLIANCE

RM 3.12 of the PRCP Schedule requires proposed flood protection landforms around proposed residual voids to be designed to:

a. *Prevent inundation during a 0.1% AEP flood event, or a less likely event than a 0.1% AEP event if required per PRCP16(b)(ii); and*
b. *Mitigate the impacts of high-energy flow (≥2.5 m/s) against the constructed landforms, using techniques such as, but are not limited to, energy dissipation measures (e.g. rock lining) and consideration of surface roughness to increase erosional resistance of the landform surface and ensure stability of the landforms.*

On the basis of the above, it was assumed that sections of the final landform would be considered at risk of flood-induced erosion if exposed to flood velocities greater than 2.5 m/s during a 0.1% AEP design flood event.

6.3 FLOOD RISK ASSESSMENT

6.3.1 Bonnie Doon Creek catchment

Figure 6.1 and Figure 6.2 show the predicted 0.1 % AEP peak flood extents, levels, depths, and velocities along Bonnie Doon Creek in the vincity of the final landform.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C, as follows:

- Peak flood depths and extents - Figure C.1 and Figure C.2.
- Peak flood velocities - Figure C.3 and Figure C.4.

The model results indicate that:

- The R8 and Bonnie Doon voids would have 0.1% AEP flood immunity. These voids would be located outside of the Bonny Doon Creek floodplain.
- Flood velocities along the toe of rehabilitated overburden areas are generally less than 1 m/s for events up to 0.1% AEP. Hence the erosion risk in these areas is considered low.

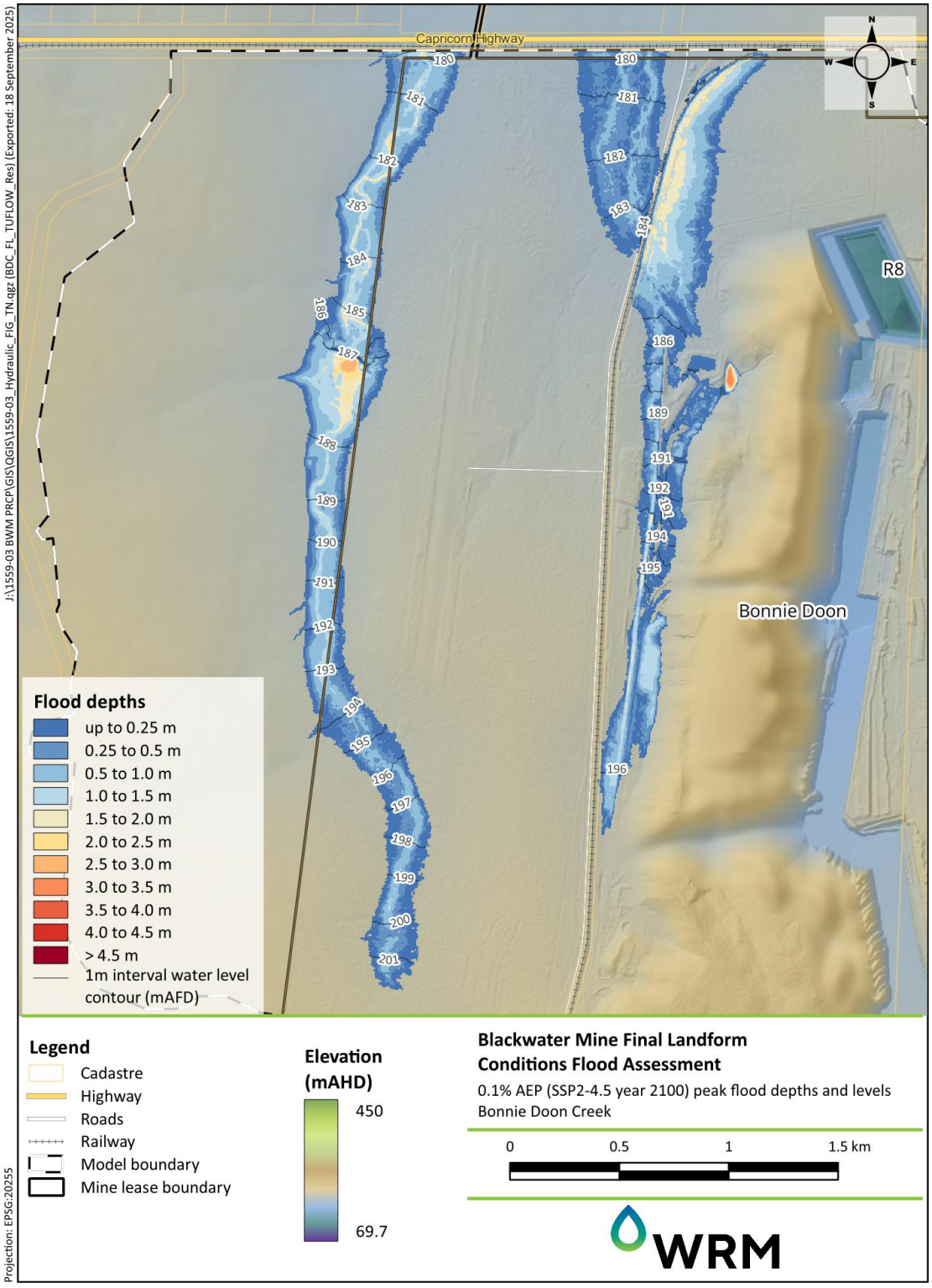


Figure 6.1 Final landform conditions 0.1% AEP peak flood depths, levels and extents, Bonnie Doon Creek

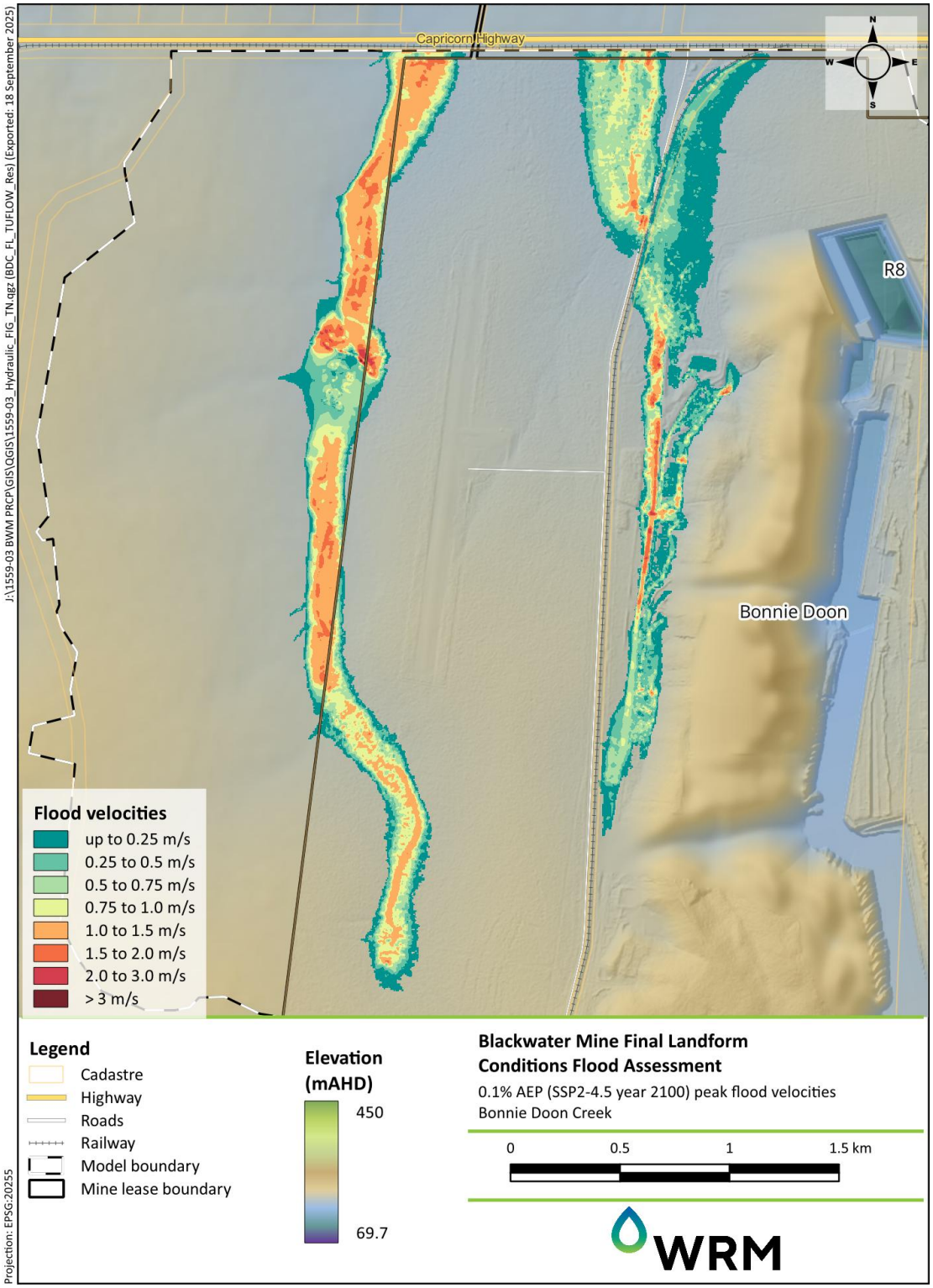


Figure 6.2 Final landform conditions 0.1% AEP peak velocities, Bonnie Doon Creek

6.3.2 Sagittarius Creek catchment

Figure 6.3 and Figure 6.4 show the predicted 0.1 % AEP peak flood extents, levels, depths, and velocities along Sagittarius Creek.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C, as follows:

- Peak flood depths and extents - Figure C.5 and Figure C.6.
- Peak flood velocities - Figure C.7 and Figure C.8.

The model results indicate that:

- The Bonnie Doon void would have 0.1% AEP flood immunity. This void would be located outside of the Sagittarius Creek floodplain.
- Rehabilitated overburden areas would be located outside of the Sagittarius Creek floodplain.

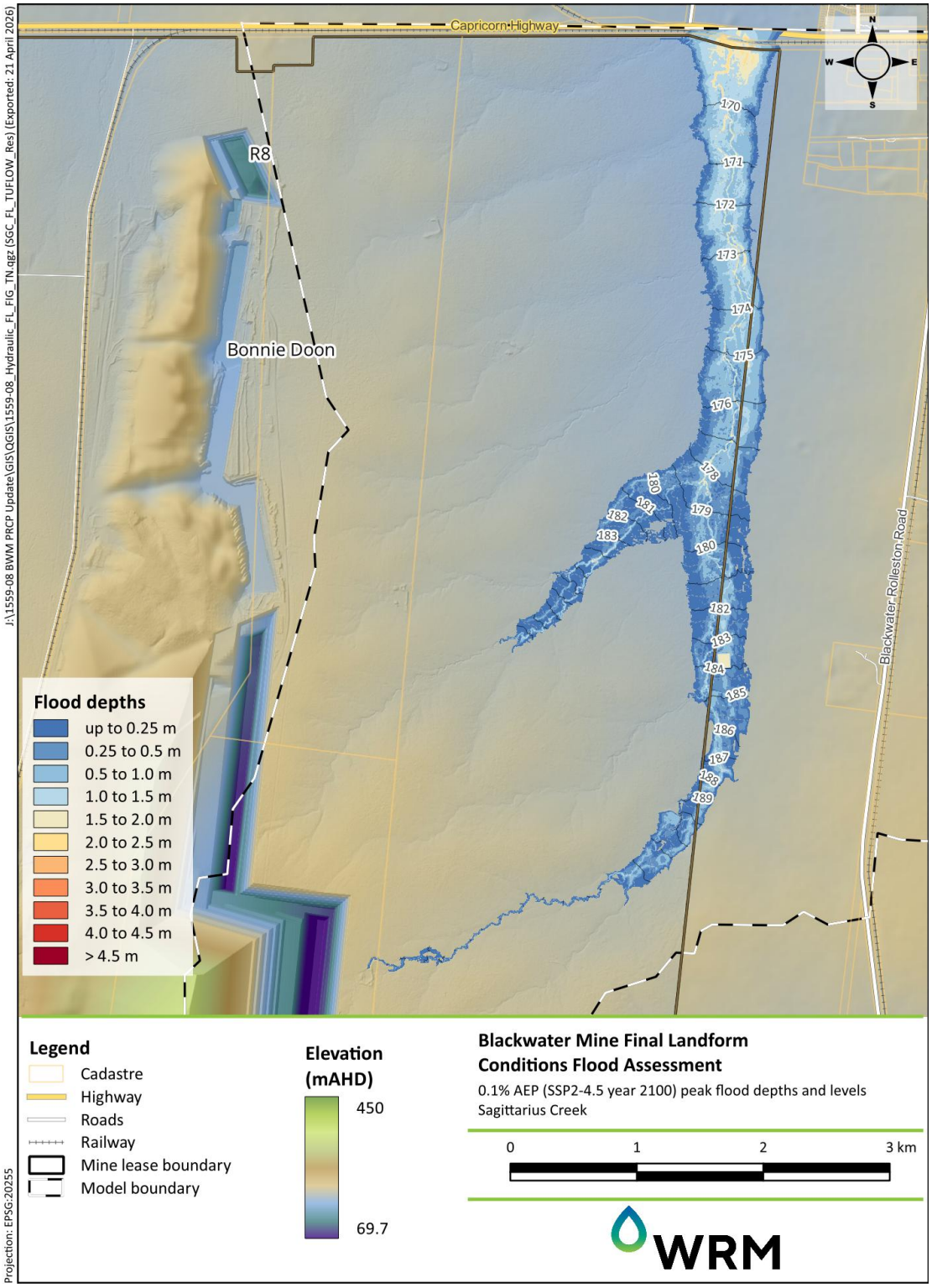


Figure 6.3 Final landform conditions 0.1% AEP peak flood depths, levels and extents, Sagittarius Creek

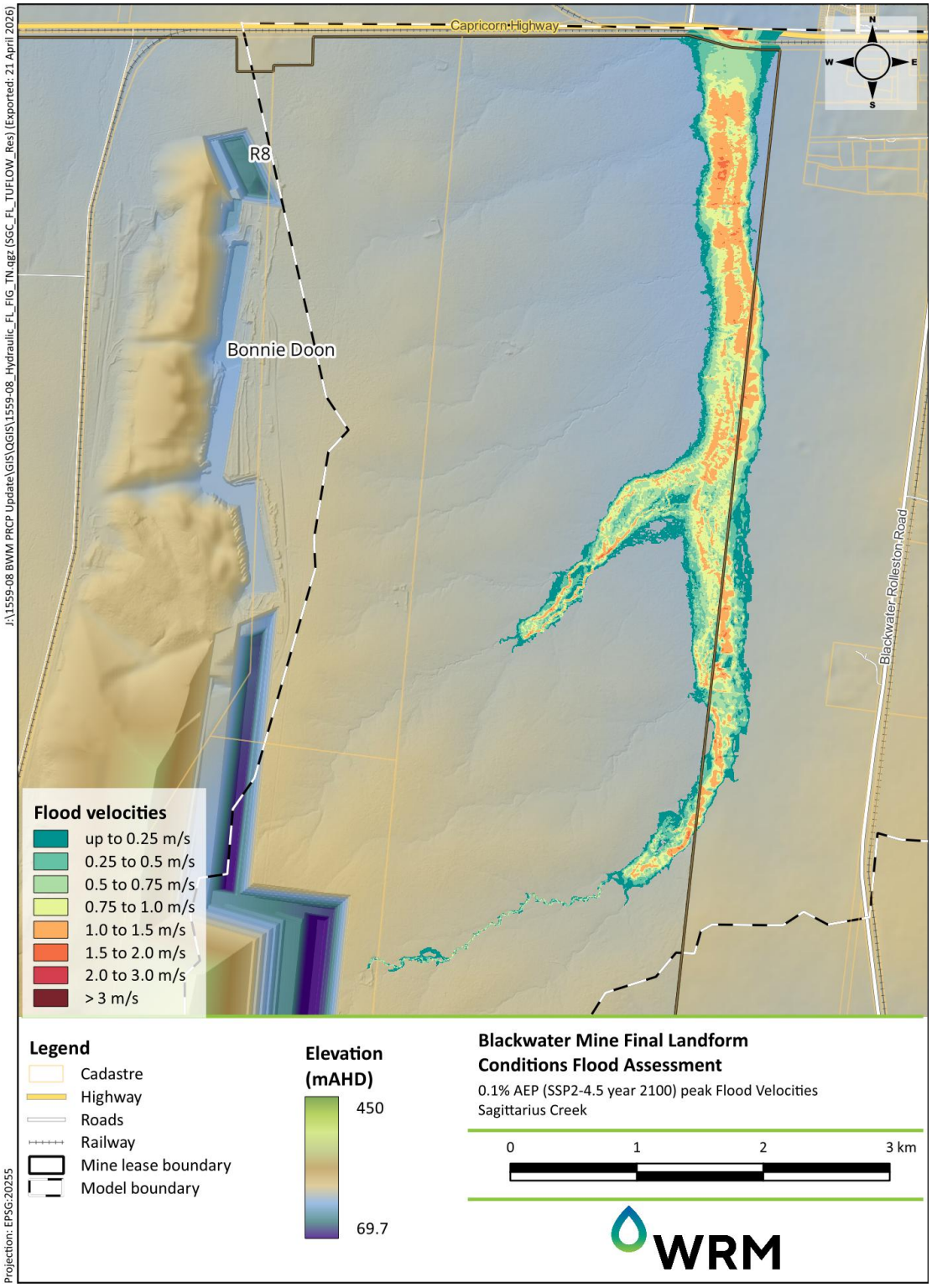


Figure 6.4 Final landform conditions 0.1% AEP peak velocities, Sagittarius Creek

6.3.3 Burngrove Creek catchment

Figure 6.5 and Figure 6.2 show the predicted 0.1 % AEP peak flood extents, levels, depths, and velocities along Burngrove Creek in the vincity of the final landform.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C as following:

- Peak flood depths and extents - Figure C.9 and Figure C.10.
- Peak flood velocities - Figure C.11 and Figure C.12.

The model results indicate that:

- The Mimosa Besgrove void would have 0.1% AEP flood immunity.
- Flood velocities along the toe of rehabilitated overburden areas (east of the Burngrove Creek Diversion) are generally less than 2 m/s for events up to 0.1% AEP. Hence the erosion risk in these areas is considered low.
- Velocities exceeding 2 m/s for the 0.1% AEP event are generally confined to the Burngrove Creek Diversion.

Note, the Burngrove Creek diversion is a licensed diversion (authorisation reference 40137F). Prior to relinquishment of the diversion license, a functional design assessment will assess whether the diversion meets the licence relinquishment criteria, or if additional remediation works are required. Additional remediation works to meet the functional design will be documented in future PRCPs.

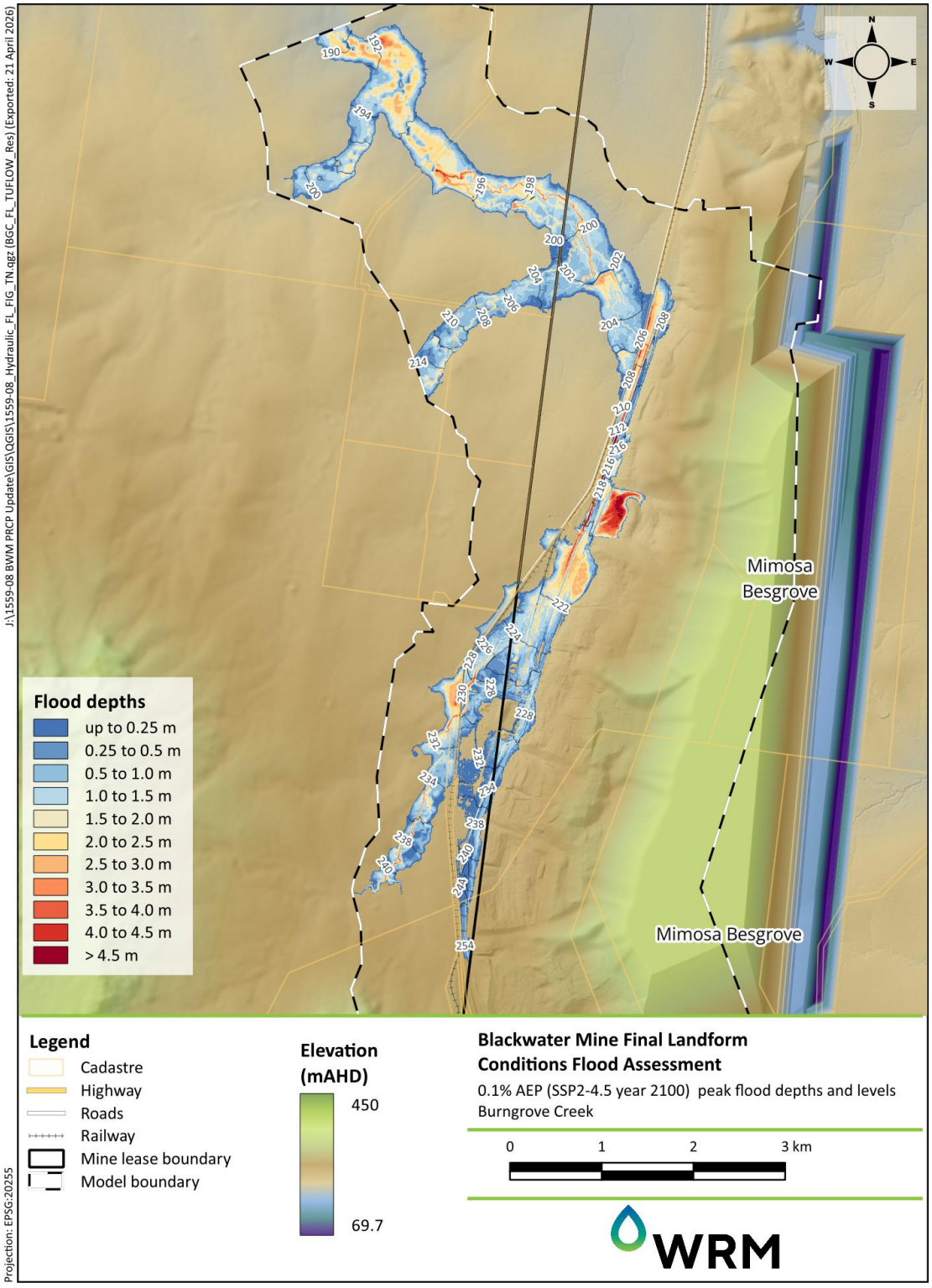


Figure 6.5 Final landform conditions 0.1% AEP peak flood depths, levels and extents, Burngrove Creek

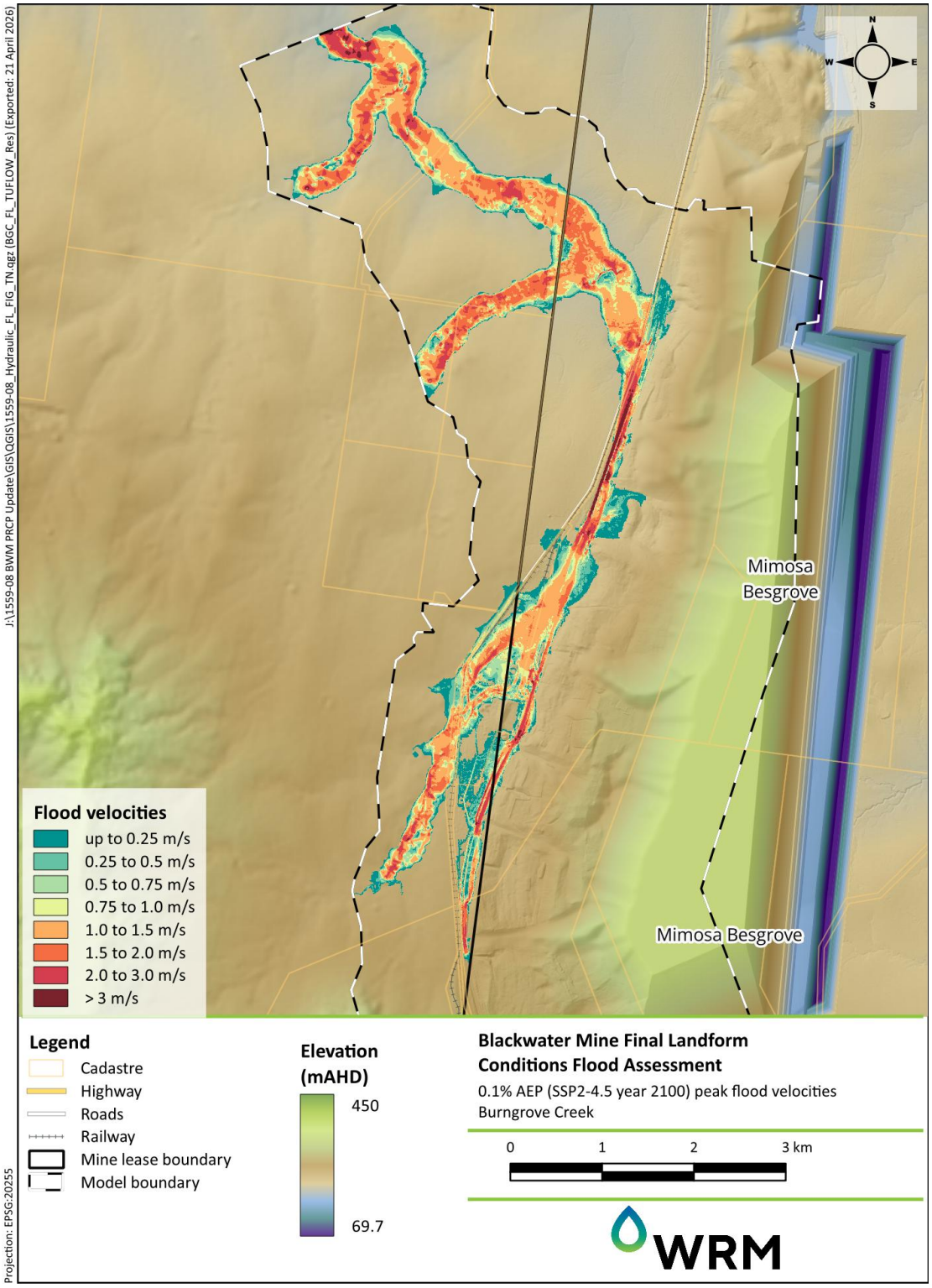


Figure 6.6 Final landform conditions 0.1% AEP peak velocities, Burngrove Creek

6.3.4 Blackwater Creek catchment (including Deep Creek, Taurus Creek and Two Mile Gully)

Figure 6.7 shows the predicted 0.1 % AEP peak flood depths, levels and extents along Emu Creek, Deep Creek, Taurus Creek and Two Mile Gully in the vincity of the final landform including the Mimosa Besgrove, R30, Deep Creek, Stewarton North and Stewarton South voids. Figure 6.9 shows the corresponding peak velocities.

Figure 6.8 shows the predicted 0.1 % AEP peak flood depths, levels and extents along Two Mile Gully in the vincity of the final landform and the Tannyfoil Void. Figure 6.10 shows the corresponding peak velocities.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C as following:

- Peak flood depths and extents - Figure C.13 to Figure C.16.
- Peak flood velocities - Figure C.17 to Figure C.20.

The model results indicate that:

- The Mimosa Besgrove, Deep Creek, Stewarton North, Stewarton South and Tannyfoil voids would have 0.1% AEP immunity.
- The R30 Void would have 0.1% AEP immunity. However, floodwater ingress into the R30 Void is predicted to occur during a PMF event. Section 6.3.8 describes how the risk of floodwater ingress into the R30 Void during events rarer than 0.1% AEP would be mitigated.
- Flood velocities along the toe of the proposed flood protection landform adjacent to the voids, for all events up to 0.1% AEP, are generally low (less than 1.0 m/s). Velocities of up to 2.0 m/s are predicted in isolated areas adjacent to the R30 void for events up to 0.1% AEP. These velocities are below the 2.5 m/s threshold for potential erosion risk from the PRCP Schedule.
- Flood velocities along the toe of rehabilitated overburden areas (adjacent to Deep Creek, Taurus Creek and Emu Creek) are generally less than 2.5 m/s for events up to 0.1% AEP, generally below the 2.5 m/s threshold for potential erosion risk from the PRCP Schedule.
- There are localised areas along the toe of rehabilitated overburden adjacent to Taurus Creek where velocities are predicted exceed 2.5 m/s during a 0.1% AEP event. Section 6.3.8 describes how the risk of localised high velocities adjacent to rehabilitated overburden areas would be mitigated.
- There is potentially higher erosion risks along these isolated sections along the tow of the overburden, which will be mitigated by one or a combination of the following measures:
  - rock lining;
  - establishing denser vegetation cover; and/or
  - channel works to contain high velocity areas to the middle of the channel and away from the toe of the rehabilitated overburden areas.

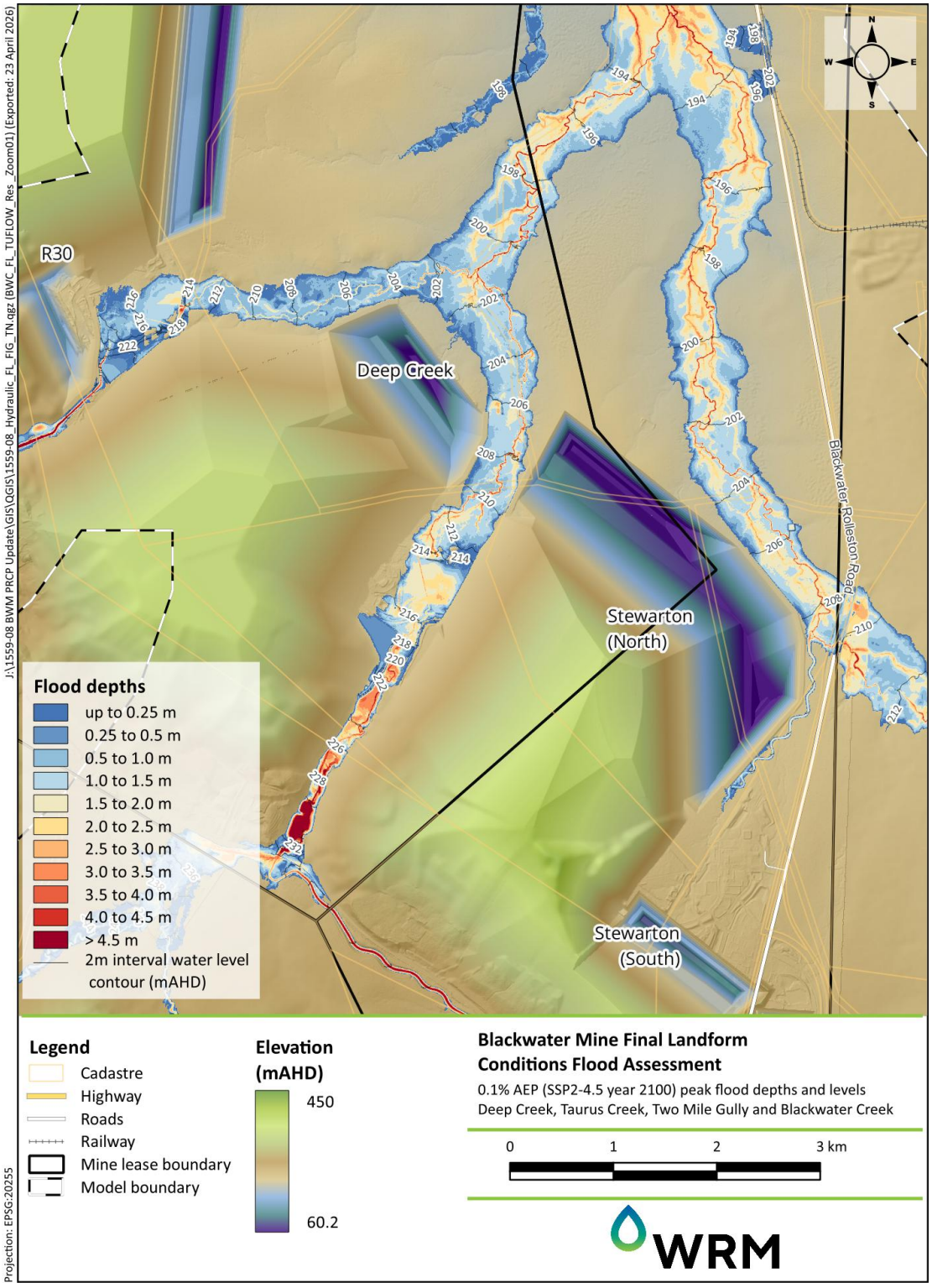


Figure 6.7 Final landform conditions 0.1% AEP peak flood depths, levels and extents, Deep Creek, Taurus Creek and Two Mile Gully (adjacent to the Stewarton South Void)

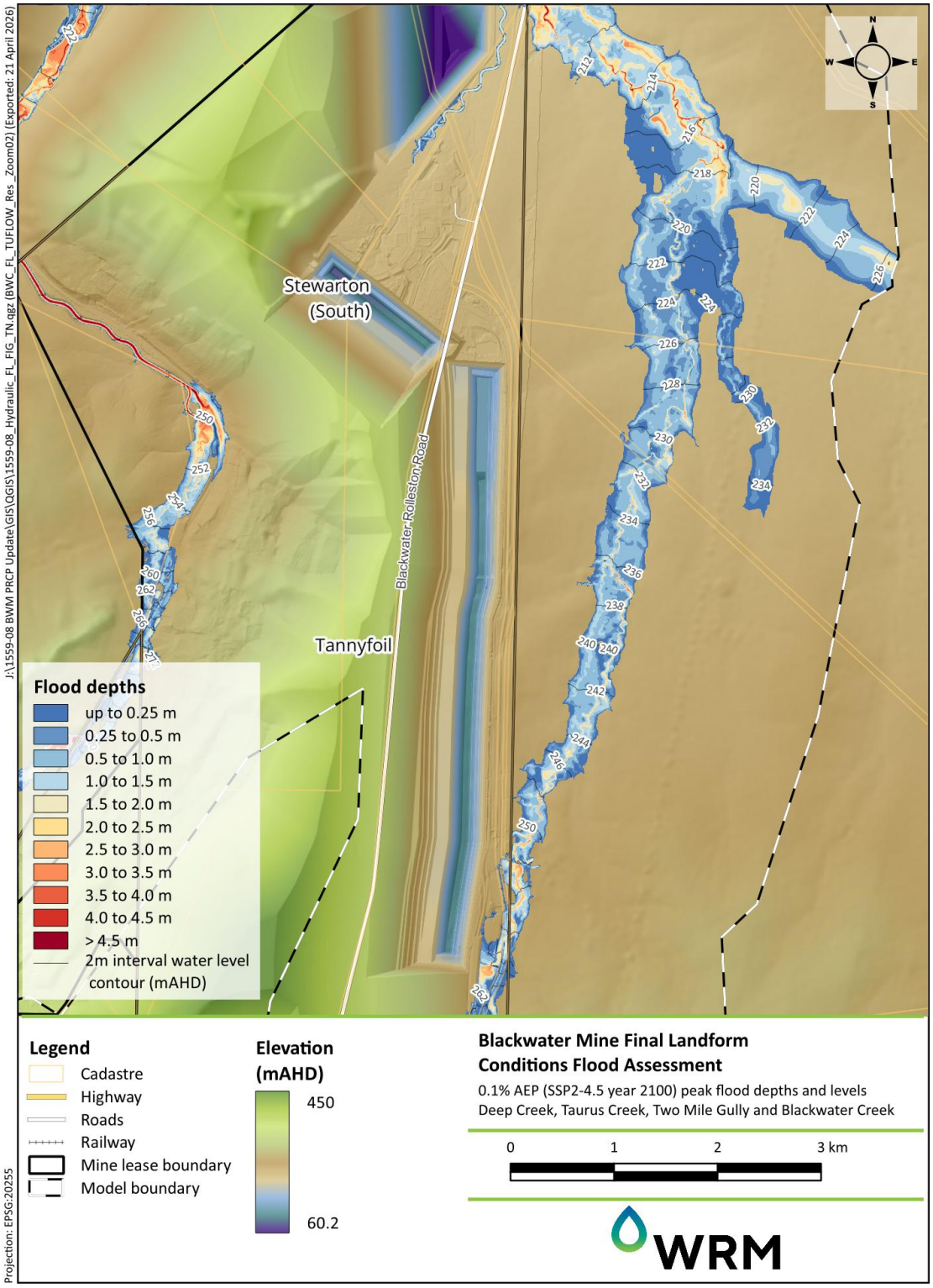


Figure 6.8 Final landform conditions 0.1% AEP peak flood depths, levels and extents, Two Mile Gully (adjacent to the Tannyfoil Void)

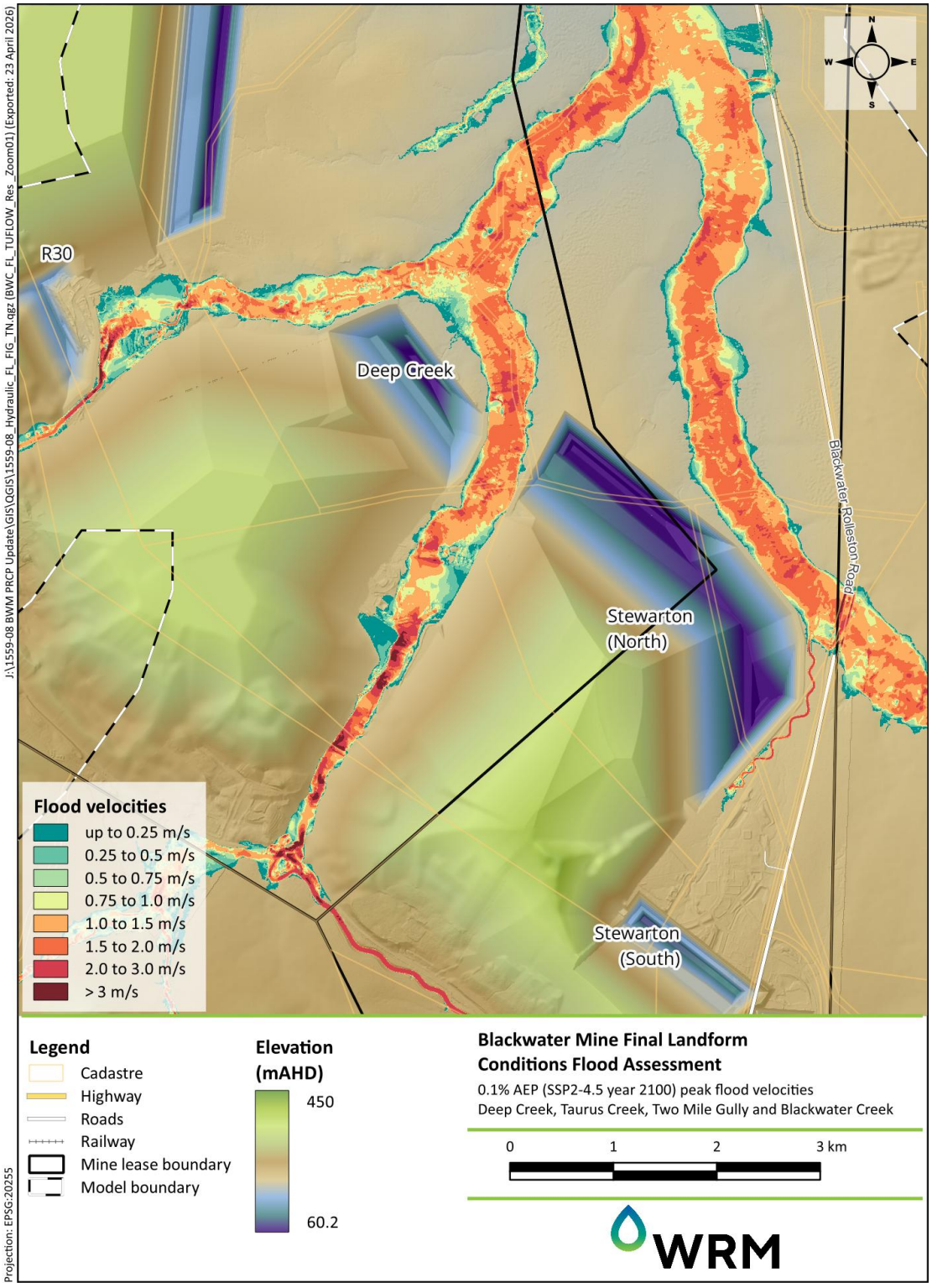


Figure 6.9 Final landform conditions 0.1% AEP peak velocities, Deep Creek, Taurus Creek and Two Mile Gully (adjacent to the Stewarton North Void)

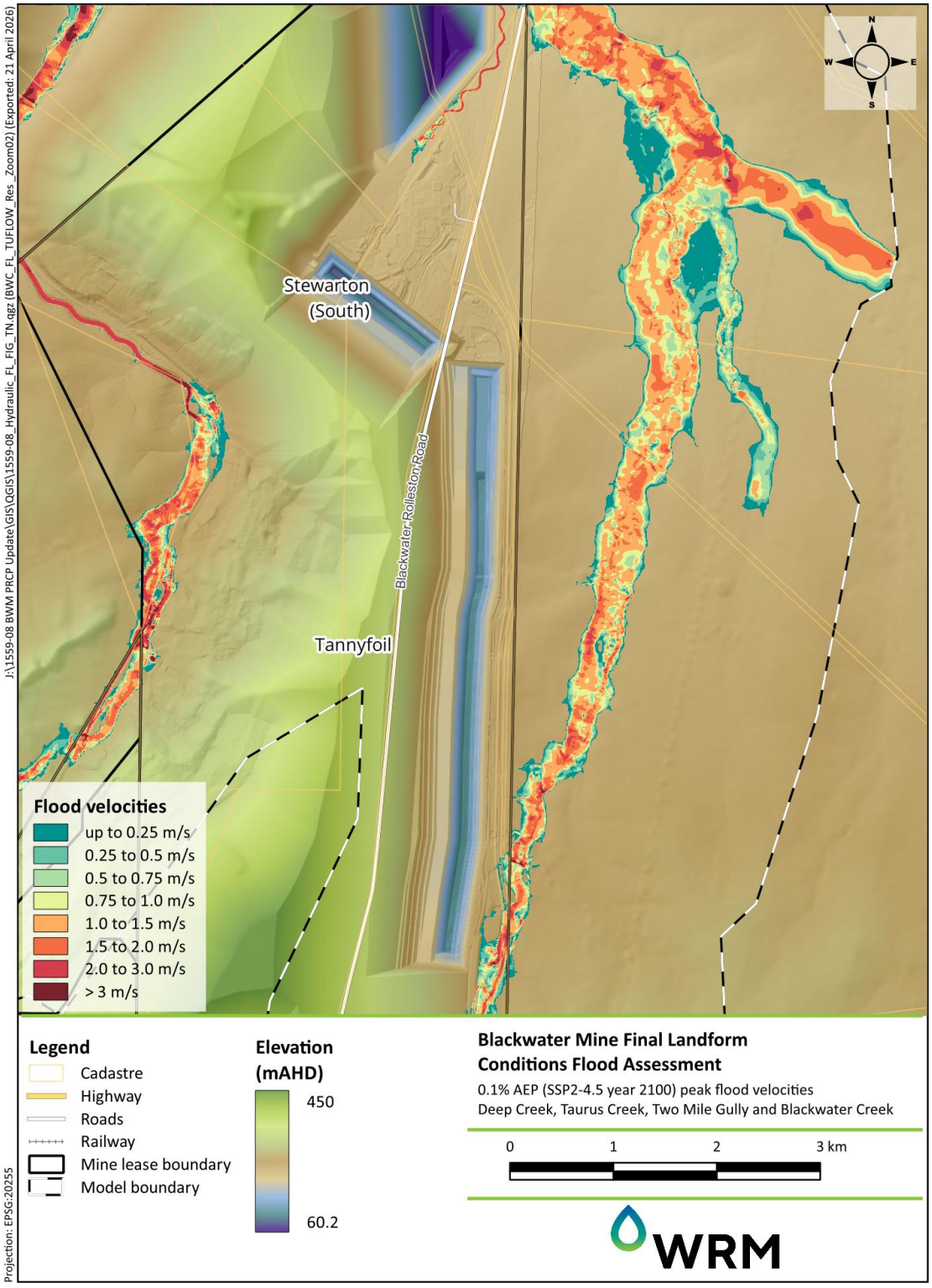


Figure 6.10 Final landform conditions 0.1% AEP peak flood velocities, Two Mile Gully (adjacent to the Tannyfoil Void)

6.3.5 Speculation Creek catchment

Figure 6.11 and Figure 6.12 show the predicted 0.1 % AEP peak flood extents, levels, depths, and velocities for Speculation Creek model, respectiverly.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C as following:

- Peak flood depths and extents - Figure C.21 and Figure C.22.
- Peak flood velocities - Figure C.23 and Figure C.24.

The model results indicate that:

- The South Ballamoo Void would have 0.1% AEP flood immunity. This void would be located outside of the Speculation Creek floodplain.
- Rehabilitated overburden areas would be located outside of the Speculation Creek floodplain.

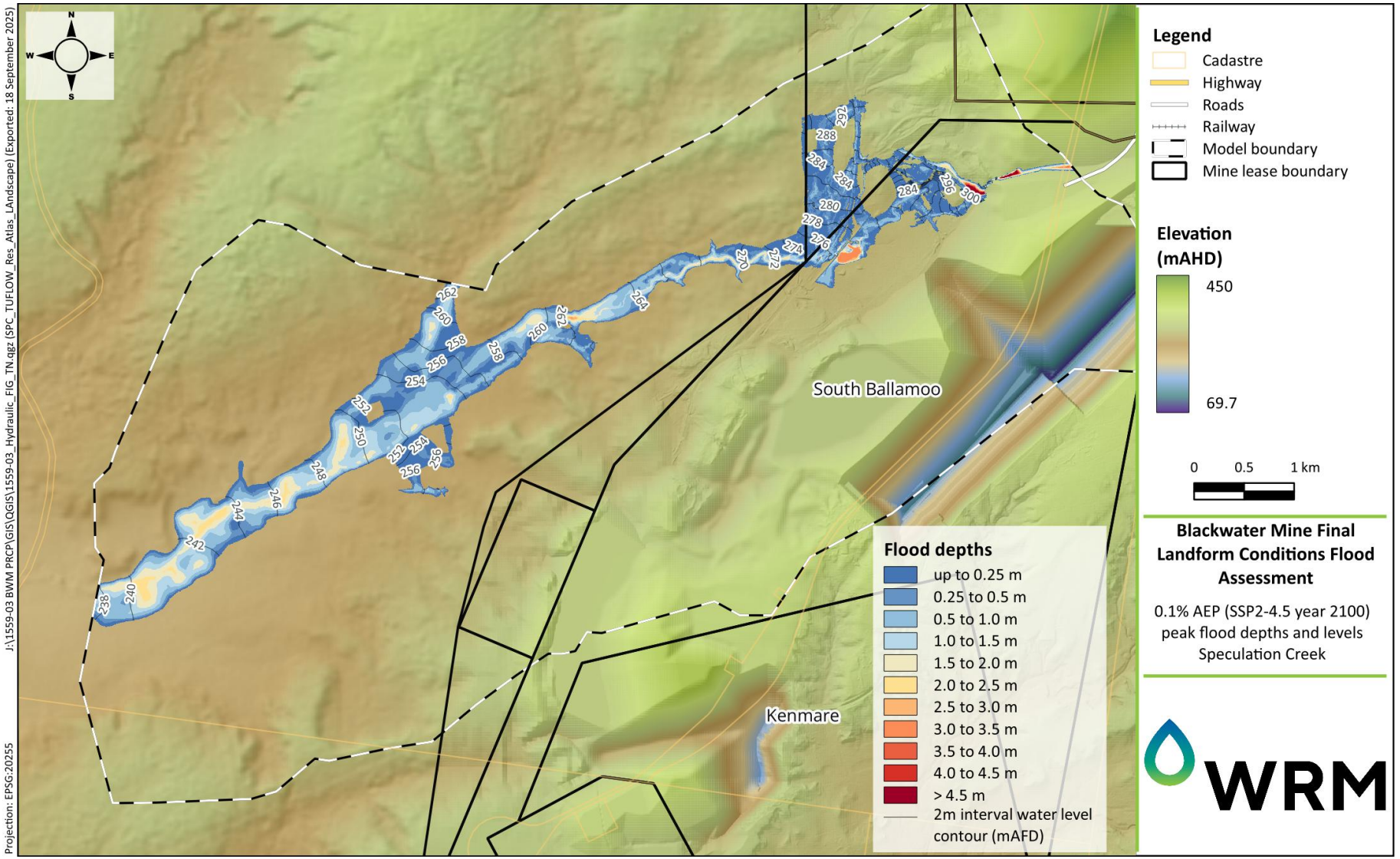


Figure 6.11 **Final landform conditions 0.1% AEP peak flood depths, levels and extents, Speculation Creek**

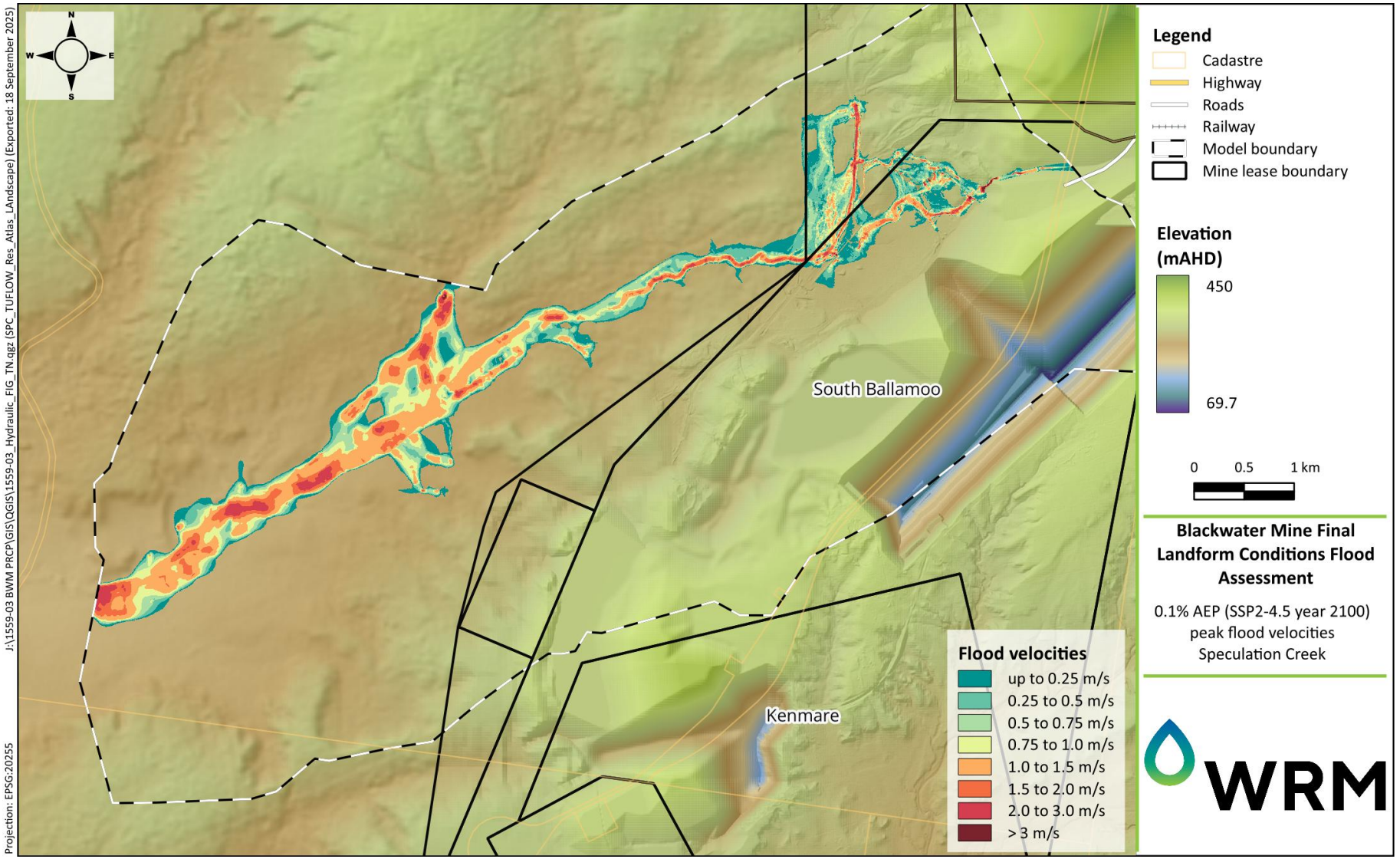


Figure 6.12 **Final landform conditions 0.1% AEP peak velocities, Speculation Creek**

6.3.6 Sirius Creek catchment

Figure 6.13 and Figure 6.14 show the predicted 0.1 % AEP peak flood extents, levels, depths, and velocities for Sirius Creek model, respectiverly.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C as following:

- Peak flood depths and extents - Figure C.25 and Figure C.26.
- Peak flood velocities - Figure C.27 and Figure C.28.

Model results indicate that:

- Under current (operational) conditions, there is a significant flood storage area formed by the R74 open cut pit's flood protection landform and the Sirius Creek Diversion. As a result, significant backwater flooding occurs over a large area upstream of the R74 pit during significant flood events under current (operational) conditions. This flood storage area would remain under post-mining conditions.
- The Togara/North Marshmead and R74 voids would have 0.1% AEP flood immunity. However, floodwater ingress into the Togara/North Marshmead and R74 voids is predicted to occur during a PMF event. Section 6.3.8 describes how the risk of floodwater ingress into these voids during events rarer than 0.1% AEP would be mitigated.
- Flood velocities adjacent to the proposed voids, for all events up to 0.1% AEP, are generally low (less than 0.5 m/s). These velocities are well below the 2.5 m/s threshold for potential erosion risk from the PRCP Schedule.
- Velocities in excess of 3 m/s are predicted in some sections of the Sirius Creek temporary diversion. Section 6.3.8 describes how the risk of high velocities along the Sirius Creek temporary diversion would be mitigated.

Note, the Sirius Creek diversion is a licensed diversion (authorisation reference 52652F). Prior to relinquishment of the diversion license, a functional design assessment will assess whether the diversion meets the licence relinquishment criteria, or if additional remediation works are required. Additional remediation works to meet the functional design will be documented in future PRCPs.

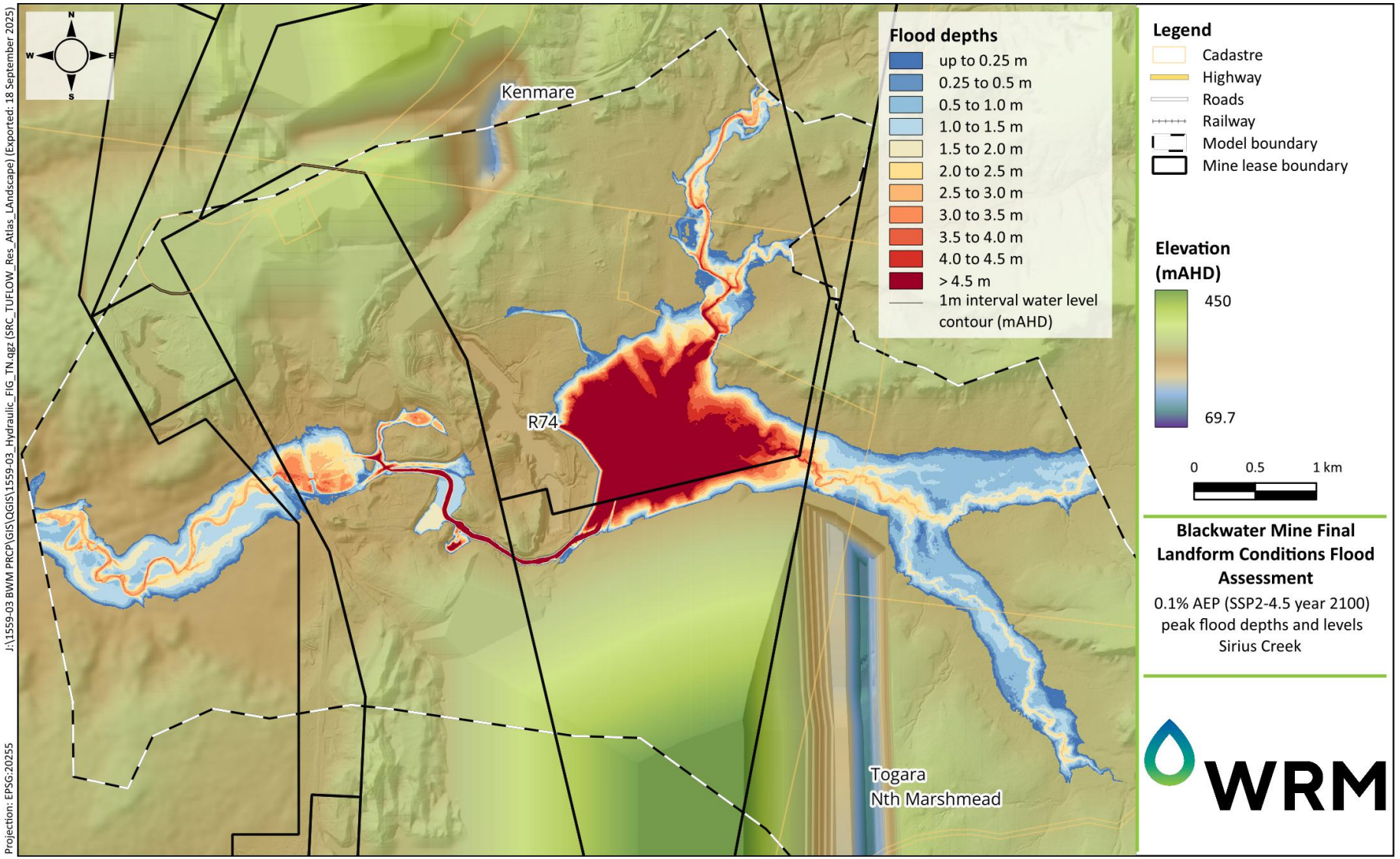


Figure 6.13 **Final landform conditions 0.1% AEP peak flood depths, levels and extents, Sirius Creek**

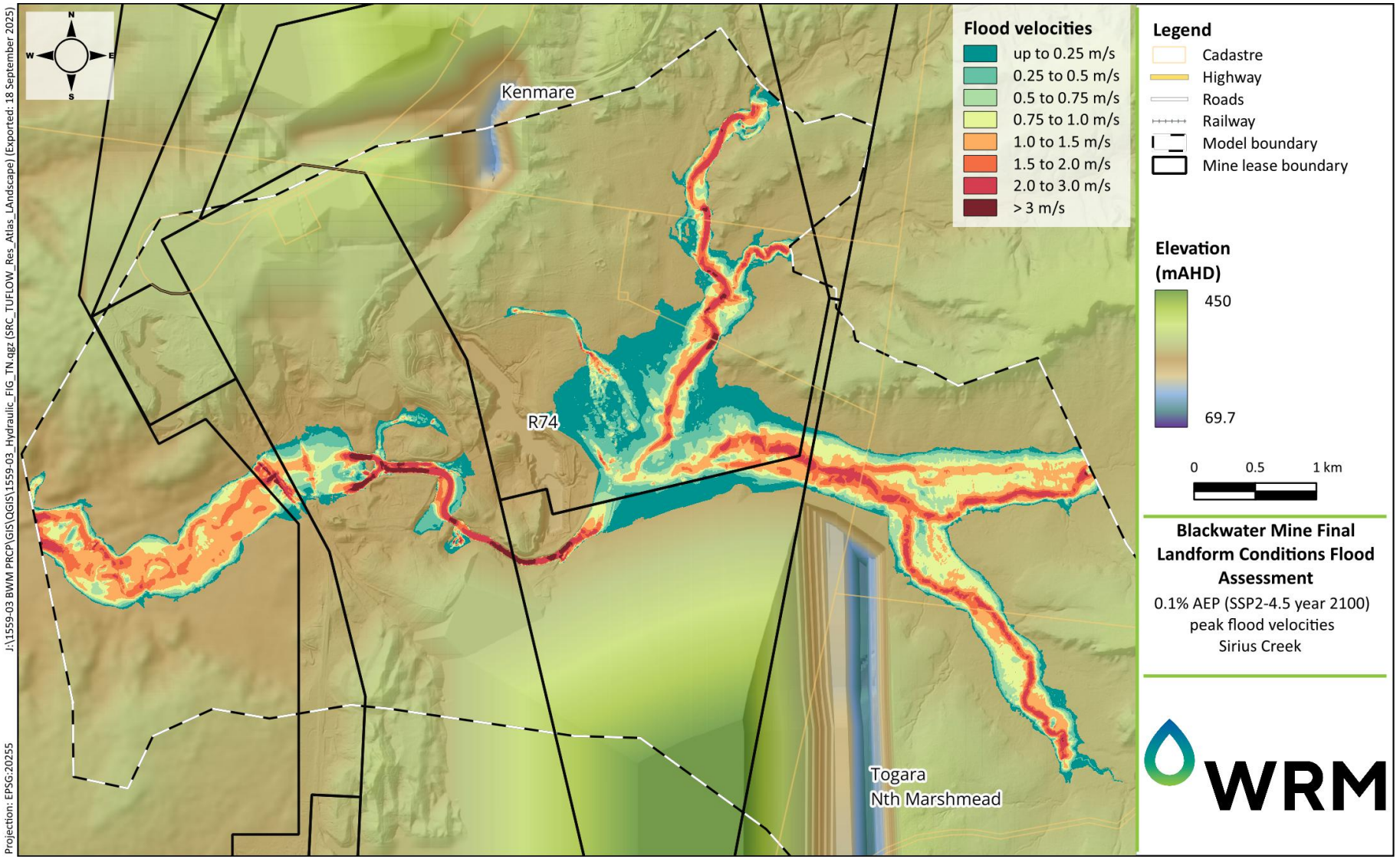


Figure 6.14 **Final landform conditions 0.1% AEP peak velocities, Sirius Creek**

6.3.7 Rockland Creek catchment

Figure 6.15 and Figure 6.16 show the predicted 0.1 % AEP peak flood extents, levels, depths, and velocities for Rockland Creek model, respectiverly.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C as following:

- Peak flood depths and extents - Figure C.29 and Figure C.30.
- Peak flood velocities - Figure C.31 and Figure C.32.

Model results indicate that:

- The South Marshmead void would have 0.1% AEP flood immunity.
- The Comet Downs East and Kennedy voids have 0.1% AEP flood immunity. However, floodwater ingress into the Comet Downs East and Kennedy voids is predicted to occur during a PMF event. Section 6.3.8 describes how the risk of floodwater ingress into these voids during events rarer than 0.1% AEP would be mitigated.
- Flood velocities along the toe of the flood protection landform adjacent to the South Marshmead void, for all events up to 0.1% AEP, are generally low (less than 0.5 m/s).
- Flood velocities along the toe of the flood protection landform adjacent to the Comet Downs East and Kennedy Voids are up to about 1.5 m/s for events up to and including the 0.1% AEP. These velocities are well below the 2.5 m/s threshold for potential erosion risk from the PRCP Schedule.

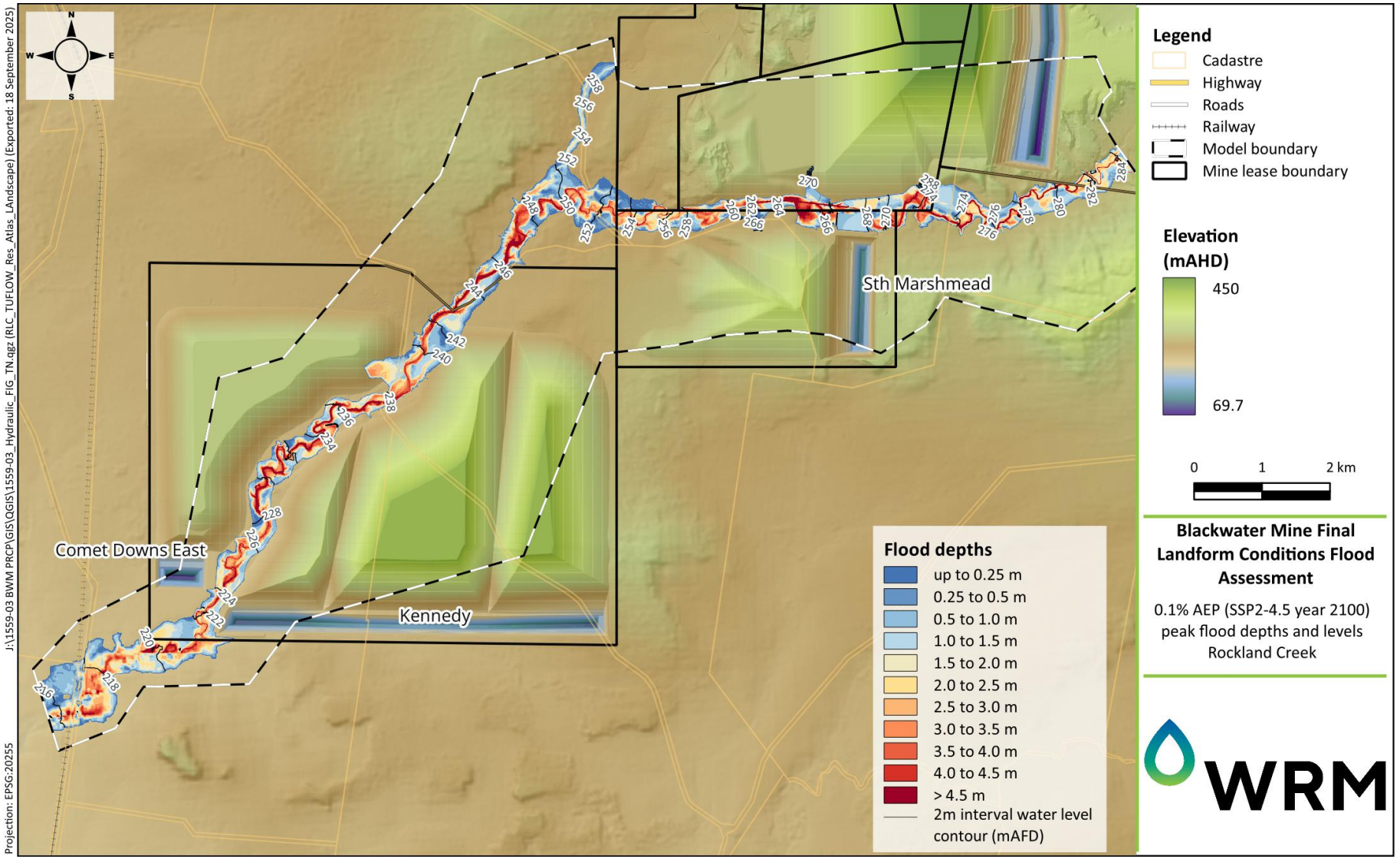


Figure 6.15 **Final landform conditions 0.1% AEP peak flood depths, levels and extents, Rockland Creek**

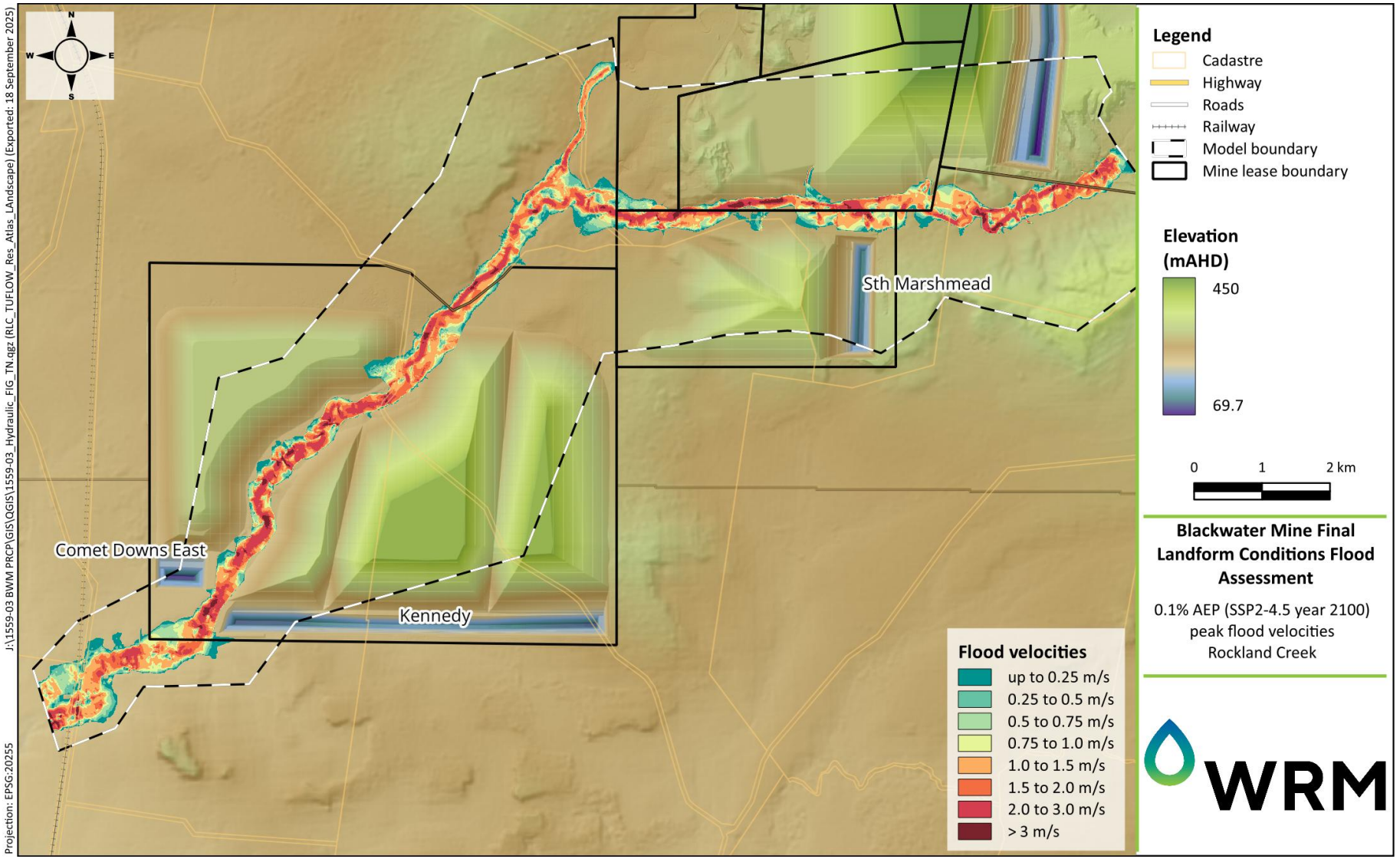


Figure 6.16 **Final landform conditions 0.1% AEP peak velocities, Rockland Creek**

6.3.8 Summary of residual flood risks and proposed mitigation measures

The hydraulic model results indicate that the BWM final landform as currently designed, would satisfy the key requirements of the PRCP guideline and the general conditions of the BWM PRCP Schedule (DETSI, 2026). However, further investigation is required to assess the following residual flood risks to the BWM final landform:

- Floodwater ingress to the R30, Togara/North Marshmead, R74, Comet Downs East and Kennedy voids during a PMF event (refer to Sections 6.3.4, 6.3.6 and 6.3.7);
- Localised high energy flows (≥2.5 m/s) in contact with the toe of rehabilitated overburden areas adjacent to Taurus Creek during a 0.1% AEP event (refer to Section 6.3.4); and
- High energy flows (≥2.5 m/s) along the Sirius Creek temporary diversion (refer to Section 6.3.6).

Table 6.1 summarises the potential consequences and proposed mitigation measures for the above residual risks.

Table 6.1 Residual flood risks and proposed mitigation measures

Risk ID	Description of risk	Potential Consequences	Mitigation measures
1	Floodwater ingress to the following voids during a PMF event: • R30 • Togara/North Marshmead • R74 • Comet Downs East • Kennedy	• Changes to the catchment hydrology and floodplain hydraulic characteristics. • Impacts on receiving water quality.	A flood susceptibility and impact assessment will be undertaken in accordance with conditions PRCP 15-17 of the PRCP Schedule. This process would include undertaking a Consequence Category Assessment (CCA) in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933) (the CCA Manual) to determine if changes to the flood protection landform design may be required based on the potential consequence of floodwater ingress into these voids.

2	Localised high energy flows (≥2.5 m/s) in contact with the toe of rehabilitated overburden areas adjacent to Taurus Creek during a 0.1% AEP event.	Erosion and scour along the toe of rehabilitated overburden areas during rare and extreme flood events.	• The final landform would be rehabilitated to achieve the minimum groundcover requirements of RM 6.3 of the PRCP Schedule.
			• One or a combination of the following additional mitigation measures may be implemented in accordance with RM 3.12 of the PRCP schedule:
			  ○ rock lining at the affected areas;
			  ○ establishing denser vegetation cover at the affected areas; and/or
			  ○ channel remediation works to divert high velocity areas along Taurus Creek away from the toe of the rehabilitated overburden areas.

3	High energy flows (≥2.5 m/s) along the Sirius Creek temporary diversion.	• Structural damage to the Sirius Creek temporary diversion channel. • Erosion and scour leading to failure of the rehabilitated overburden areas adjacent to the diversion.	• A flood susceptibility and impact assessment will be undertaken for the Sirius Creek temporary diversion in accordance with conditions PRCP 15-17 of the PRCP Schedule. This process includes undertaking a CCA in accordance with the CCA Manual to determine if remediation works may be required based on the consequence of failure of the temporary diversion during extreme flood events. • Prior to relinquishment of the diversion license, a functional design assessment will assess whether the diversion meets the licence relinquishment criteria, or if additional remediation works are required. Additional remediation works to meet the functional design will be documented in future PRCPs.

6.4 CONSIDERATION FOR ALTERATION OF FLOWS

The potential alteration of flows upstream and downstream of BWM was assessed by comparing the catchment areas of the modelled creeks between final landform conditions and existing conditions. There is insufficient pre-mining topographical data available to undertake the assessment of catchment/flow alterations from pre-mining conditions. Table 6.2 shows the percentage change in catchment areas between existing and final landform conditions. It shows that:

- The changes in catchment areas are generally insignificant.
- The largest percentage change in catchment area is 12.7% at the Burngrove Creek catchment to the western ML boundary. However, the catchment area to the western ML boundary is relatively small. At the Capricorn Highway about 6.5 km downstream of the ML boundary, the Burngrove Creek catchment area is more than three times larger and hence, the change in catchment area is less than 4% at the Capricorn Highway.
- Overall, the predicted minor changes in catchment areas are not expected to cause adverse alterations to flow upstream and downstream of BWM between existing and final landform conditions.

Table 6.2 Change in catchment areas between existing and final landform conditions

Location	Catchment area under existing conditions (km^2)	Catchment area under final landform conditions (km^2)	Change
Bonnie Doon Creek at western ML boundary	21.6	21.3	-1.3%
Burngrove Creek at Western ML boundary	45.3	51.1	12.7%
Sagittarius Creek at northern ML boundary	42.7	39.6	-7.3%
Taurus Creek at eastern ML boundary / Blackwater Creek confluence	248.9	259.5	4.3%
Speculation Creek at the Speculation Creek stream gauge	45.3	48.9	7.9%
Sirius Creek at the Sirius Creek stream gauge / western ML boundary	120.2	113.8	-5.4%
Rockland Creek at southwestern ML boundary	158.6	157.9	-0.4%
Total	**682.6**	**692.1**	**1.4%**

7 SUMMARY OF FINDINGS

7.1 OVERVIEW

Hydrologic and hydraulic modelling for the BWM final landform was undertaken to supplement the BWM PRCP. As part of the PRCP for BWM, it is proposed to incorporate 15 final voids as NUMAs.

7.2 HYDROLOGIC AND HYDRAULIC MODEL DEVELOPMENT

Hydrologic and hydraulic modelling was undertaken to assess flood behaviour under the proposed BWM final landform conditions, in support of the Blackwater Mine PRCP.

New URBS hydrologic models were developed and calibrated to recorded data for the April 2017 and January 2020 flood events where data was available. Design event hydrologic modelling was undertaken in accordance with ARR 2019, for the 1% AEP, 0.1% AEP and PMF design flood events. The new URBS models incorporate the latest climate change guidance from Australian Rainfall and Runoff 2019 Version 4.2 (ARR 2019 v4.2) (Ball et al, 2019). Design flood discharges were estimated based on the SSP2-4.5 (year 2100) future climate scenario.

TUFLOW hydraulic models previously developed by SLR (2024a and 2024b) were updated to incorporate updated BWM final landform, and to incorporate new design discharge from the new URBS hydrologic models. The updated hydraulic models were used to estimate flood levels, depths, extents and velocities for 1% AEP, 0.1% AEP and PMF design events.

7.3 FLOOD RISKS

Flood modelling results demonstrate that all 15 residual voids at BWM would have 0.1% AEP flood immunity under future (year 2100) climate conditions. Flood velocities along the toe of proposed rehabilitated overburden areas are generally less than 2.5 m/s for all events up to the 0.1% AEP design flood event, which is the threshold above which the final landform would be considered at risk of flood-induced erosion. As such, the final landform is expected to remain stable for all events up to the 0.1% AEP design flood event.

Further investigation is required to assess the following residual flood risks to the BWM final landform, and determine the appropriate mitigation measures:

- Floodwater ingress to the R30, Togara/North Marshmead, R74, Comet Downs East and Kennedy voids during a PMF event;
- Localised high energy flows (≥2.5 m/s) in contact with the toe of rehabilitated overburden areas adjacent to Taurus Creek during a 0.1% AEP event; and
- High energy flows (≥2.5 m/s) along the Sirius Creek temporary diversion.

The above residual risks will be addressed by undertaking a flood susceptibility and impact assessment in accordance with conditions PRCP 15-17 of the PRCP Schedule. This process includes undertaking a CCA in accordance with the CCA Manual to determine the appropriate mitigation measures based on the potential consequences.

7.4 CONSIDERATION FOR ALTERATION OF FLOWS

The potential alteration of flows upstream and downstream of BWM was assessed by comparing the catchment areas of the modelled creeks between final landform conditions and existing conditions. The changes in catchment areas are generally insignificant. Considering all catchments that traverse BWM, the total predicted net change in catchment areas between existing and final landform conditions is approximately 1.4% and are not expected to cause adverse alterations to flow upstream and downstream of BWM.

8 REFERENCES

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APPENDIX AURBS MODEL CONFIGURATION

A.1 BONNIE DOON CREEK (BDC) CATCHMENT

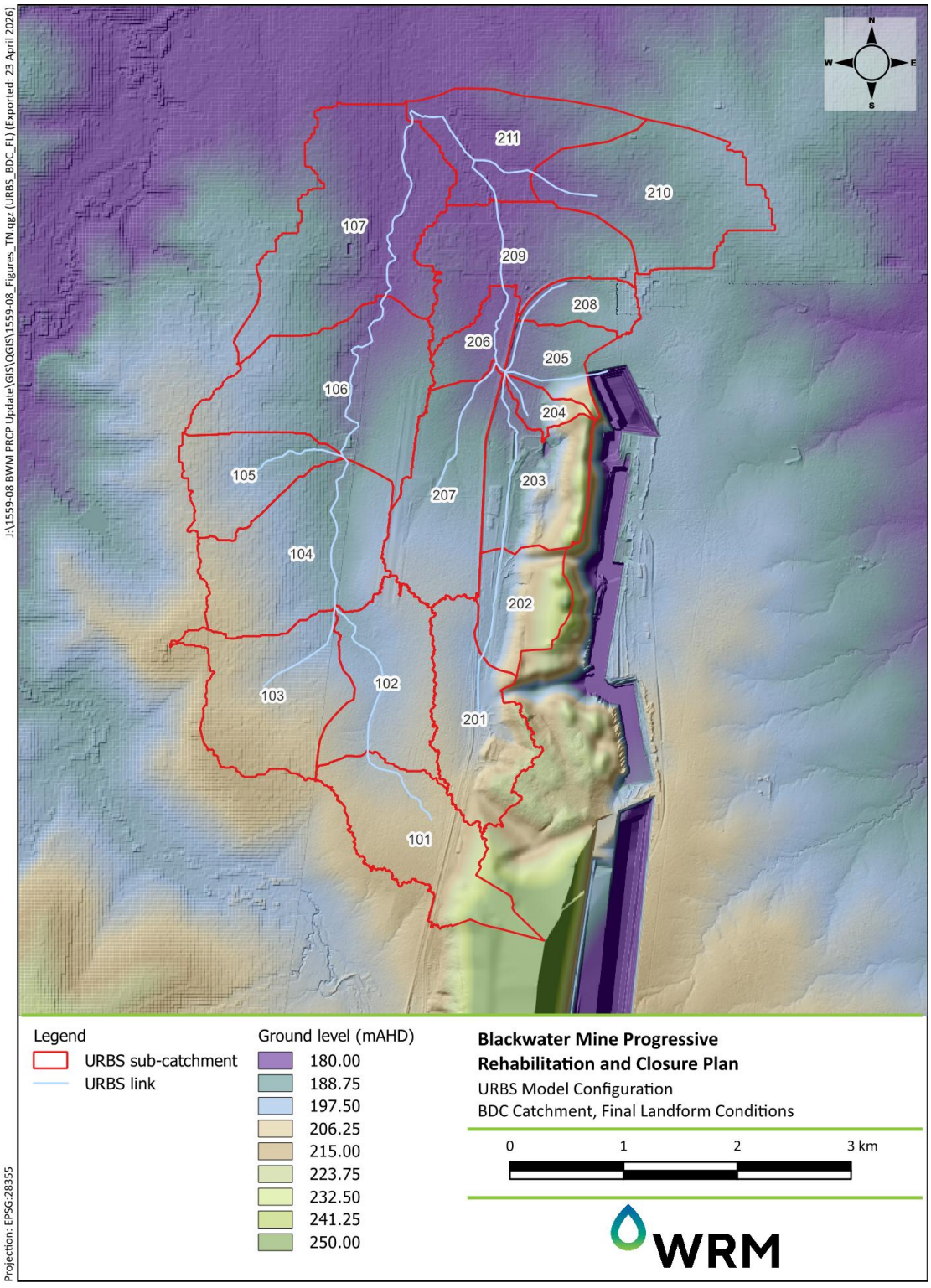


Figure A.1 URBS model configuration, Bonnie Doon Creek catchment, final landform conditions

Table A.1 URBS model subcatchment parameters, Bonnie Doon Creek catchment

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.37	0	0.035	0.019
102	1.26	0	0.035	0.006
103	1.46	0	0.035	0.010
104	1.83	0	0.035	0.007
105	0.83	0	0.035	0.011
106	2.02	0	0.035	0.005
107	2.46	0	0.035	0.007
201	1.20	0	0.035	0.009
202	0.73	0	0.035	0.031
203	1.07	0	0.035	0.012
204	0.18	0	0.035	0.026
205	0.47	0	0.035	0.033
206	0.39	0	0.035	0.005
207	1.36	0	0.035	0.007
208	0.38	0	0.035	0.006
209	1.39	0	0.035	0.007
210	1.72	0	0.035	0.006
211	1.19	0	0.035	0.005

A.2 SAGITTARIUS CREEK (SGC) CATCHMENT

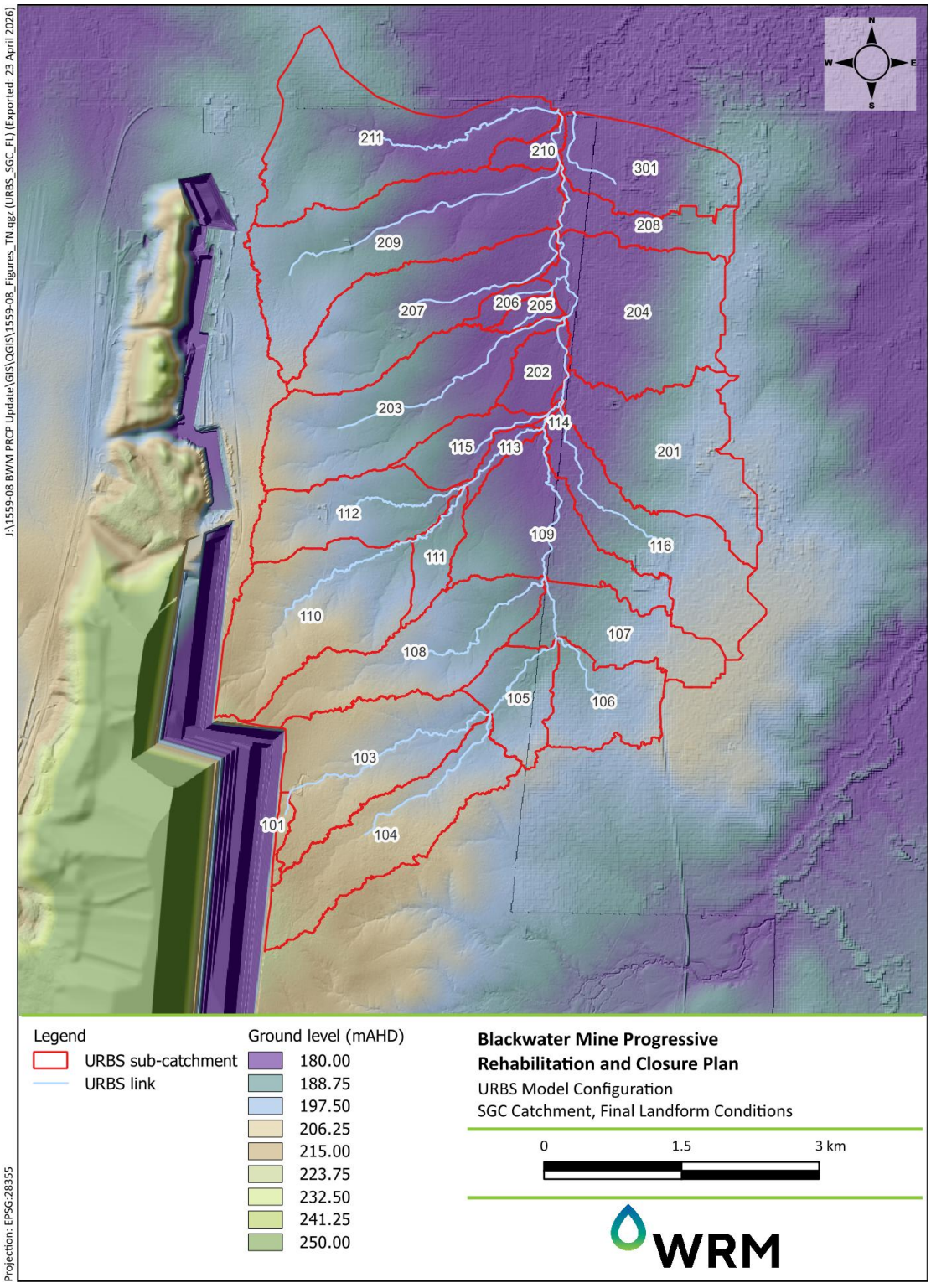


Figure A.2 URBS model configuration, Sagittarius Creek catchment, final landform conditions

Table A.2 URBS model subcatchment parameters, Sagittarius Creek catchment

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	0.11	0	0.070	0.008
103	2.25	0	0.070	0.007
104	2.10	0	0.070	0.007
105	0.87	0	0.070	0.007
106	1.14	0	0.070	0.008
107	1.37	0	0.070	0.009
108	2.18	0	0.070	0.008
109	2.02	0	0.070	0.007
110	2.57	0	0.070	0.008
111	0.46	0	0.070	0.009
112	1.46	0	0.070	0.009
113	0.19	0	0.070	0.007
114	0.02	0	0.070	0.005
115	0.63	0	0.070	0.007
116	2.12	0	0.070	0.007
201	2.44	0	0.070	0.010
202	0.51	0	0.070	0.004
203	2.72	0	0.070	0.007
204	2.69	0	0.070	0.010
205	0.17	0	0.070	0.007
206	0.20	0	0.070	0.007
207	2.22	0	0.070	0.008
208	0.81	0	0.070	0.008
209	3.34	0	0.070	0.007
210	0.27	0	0.070	0.003
211	3.14	0	0.070	0.005
301	1.58	0	0.070	0.008

A.3 BURNGROVE CREEK (BGC) CATCHMENT

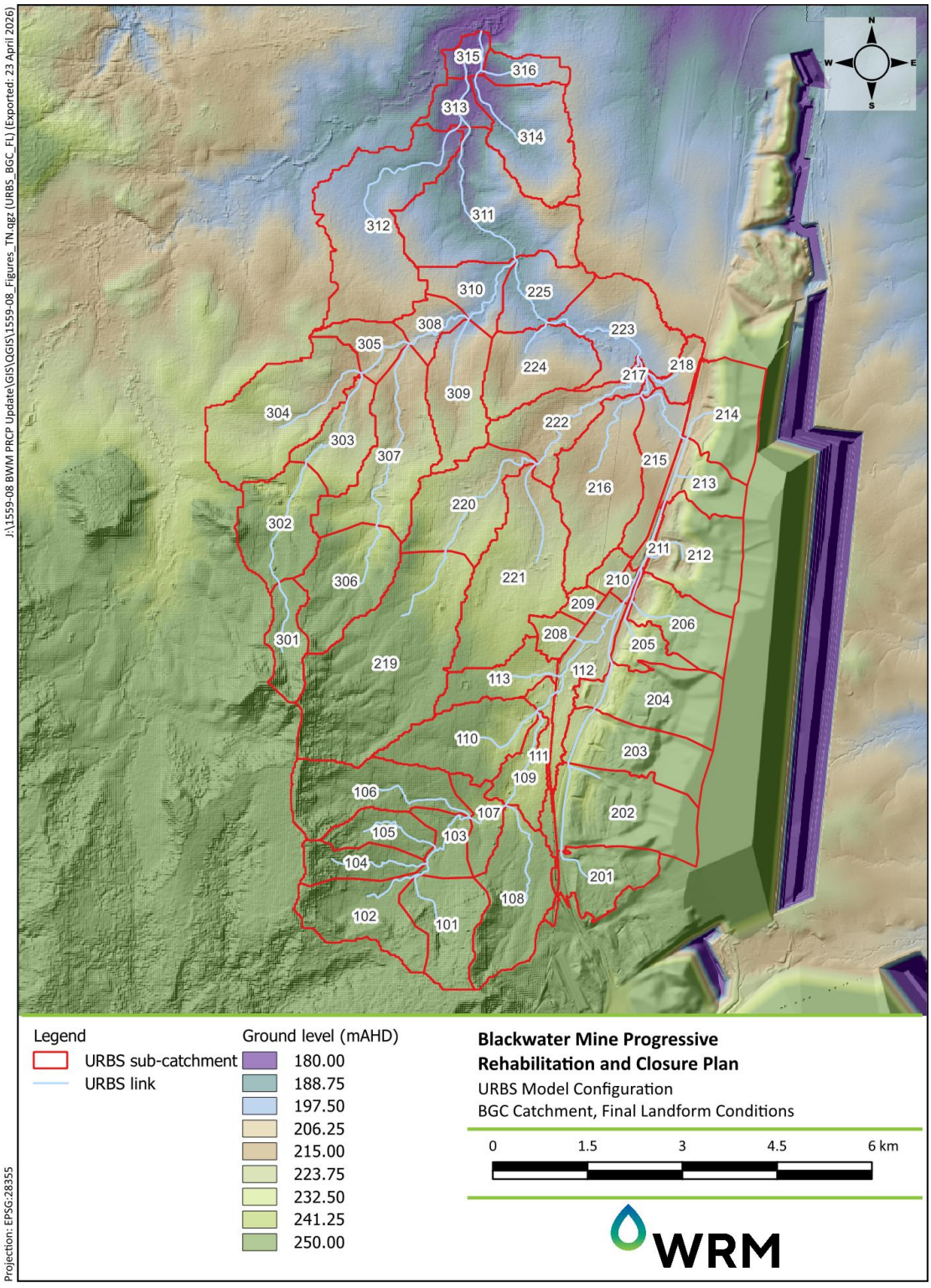


Figure A.3 URBS model configuration, Burngrove Creek catchment, final landform conditions

Table A.3 URBS model subcatchment parameters, Burngrove Creek catchment

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.66	0	0.035	0.017
102	1.90	0	0.035	0.019
103	0.72	0	0.035	0.007
104	0.96	0	0.035	0.010
105	0.89	0	0.035	0.009
106	2.25	0	0.035	0.023
107	0.72	0	0.035	0.007
108	2.37	0	0.035	0.024
109	0.87	0	0.035	0.009
110	2.07	0	0.035	0.021
111	0.54	0	0.035	0.005
112	1.22	0	0.035	0.012
113	1.04	0	0.035	0.010
201	1.35	0	0.035	0.022
202	2.68	0	0.035	0.037
203	1.91	0	0.035	0.042
204	2.04	0	0.035	0.047
205	0.68	0	0.035	0.052
206	1.42	0	0.035	0.047
207	0.15	0	0.035	0.002
208	0.41	0	0.035	0.004
209	0.25	0	0.035	0.003
210	0.27	0	0.035	0.003
211	0.17	0	0.035	0.012
212	2.00	0	0.035	0.033
213	0.98	0	0.035	0.032
214	1.80	0	0.035	0.047
215	1.26	0	0.035	0.013
216	2.89	0	0.035	0.029
217	0.06	0	0.035	0.001
218	0.42	0	0.035	0.004
219	5.72	0	0.035	0.057
220	2.24	0	0.035	0.022
221	3.52	0	0.035	0.035

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
222	1.69	0	0.035	0.017
223	2.17	0	0.035	0.022
224	1.87	0	0.035	0.019
225	1.26	0	0.035	0.013
301	0.93	0	0.035	0.009
302	2.00	0	0.035	0.020
303	1.33	0	0.035	0.013
304	3.27	0	0.035	0.033
305	0.76	0	0.035	0.008
306	2.17	0	0.035	0.022
307	2.89	0	0.035	0.029
308	0.63	0	0.035	0.006
309	1.81	0	0.035	0.018
310	1.00	0	0.035	0.010
311	3.79	0	0.035	0.038
312	4.12	0	0.035	0.041
313	0.61	0	0.035	0.006
314	2.26	0	0.035	0.023
315	0.40	0	0.035	0.010
316	0.58	0	0.035	0.010

A.4 BLACKWATER CREEK (BWC) CATCHMENT

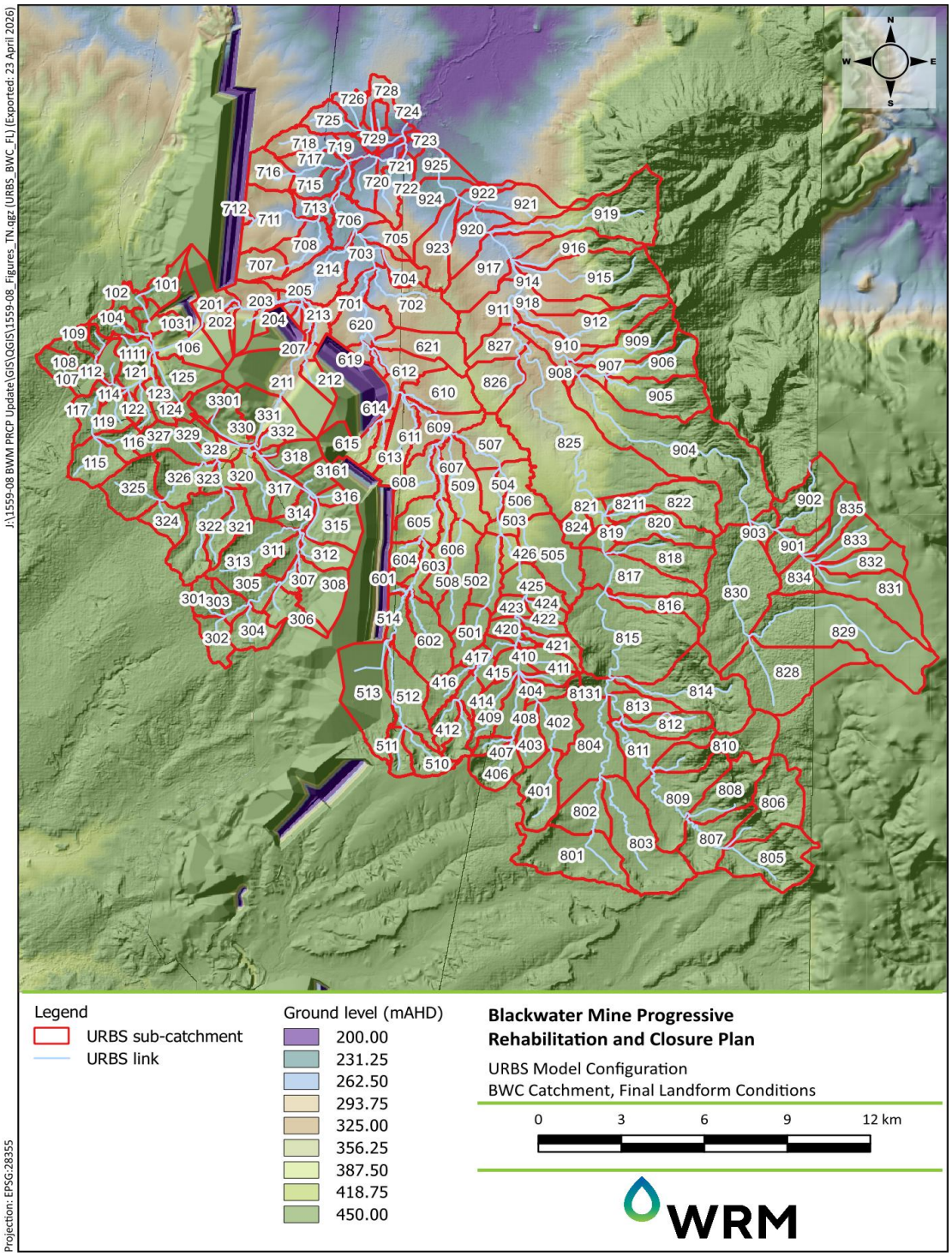


Figure A.4 URBS model configuration, Blackwater Creek catchment (including Deep Creek, Taurus Creek and Two Mile Gully), final landform conditions

Table A.4 URBS model subcatchment parameters, Blackwater Creek catchment

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.48	0	0.08	0.039
102	0.88	0	0.08	0.009
103	0.47	0	0.08	0.022
104	0.97	0	0.08	0.028
105	0.51	0.5	0.07	0.021
106	2.85	0	0.07	0.052
107	2.02	0	0.10	0.030
108	1.10	0	0.10	0.070
109	0.65	0	0.10	0.028
110	0.42	0	0.10	0.044
111	0.02	0	0.07	0.006
112	0.10	0	0.07	0.009
113	0.99	0.5	0.07	0.005
114	0.33	0	0.07	0.020
115	2.55	0	0.08	0.017
116	1.21	0	0.08	0.015
117	1.61	0	0.08	0.012
118	0.28	0	0.07	0.010
119	1.14	0	0.07	0.036
120	0.50	0	0.07	0.029
121	1.40	0	0.08	0.009
122	0.79	0	0.07	0.023
123	1.05	0	0.08	0.018
124	0.60	0	0.08	0.027
125	2.70	0	0.80	0.013
201	3.69	0	0.07	0.030
202	0.33	0	0.07	0.072
203	2.46	0	0.07	0.033
204	0.51	0	0.07	0.032
205	0.31	0	0.07	0.002
206	0.20	0	0.07	0.008
207	0.15	0	0.07	0.007
208	0.40	0	0.07	0.003
209	0.20	0	0.07	0.008

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
211	6.33	0	0.07	0.026
212	0.98	0	0.07	0.070
213	0.94	0	0.07	0.004
214	3.78	0	0.07	0.004
301	1.34	0	0.07	0.033
302	1.71	0	0.07	0.018
303	1.05	0	0.07	0.026
304	2.10	0	0.07	0.026
305	1.23	0	0.07	0.009
306	1.79	0	0.07	0.038
307	0.62	0	0.07	0.030
308	3.47	0	0.07	0.048
311	1.08	0	0.07	0.015
312	1.74	0	0.07	0.037
313	4.53	0	0.07	0.017
314	1.21	0	0.07	0.004
315	2.80	0	0.07	0.033
316	0.68	0	0.07	0.074
317	1.81	0	0.07	0.009
318	1.84	0	0.07	0.041
319	0.22	0	0.07	0.105
320	2.47	0	0.07	0.013
321	2.35	0	0.07	0.017
322	4.18	0	0.07	0.016
323	1.05	0	0.07	0.013
324	1.70	0	0.07	0.019
325	3.44	0	0.08	0.023
326	3.05	0	0.07	0.013
327	2.57	0	0.07	0.013
328	0.67	0	0.07	0.004
329	1.04	0	0.07	0.015
330	2.11	0	0.07	0.023
331	3.40	0	0.07	0.048
332	0.55	0	0.07	0.045
401	3.50	0	0.07	0.015

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
402	2.59	0	0.07	0.011
403	1.73	0	0.07	0.012
404	0.92	0	0.07	0.017
405	0.74	0	0.07	0.032
406	2.38	0	0.07	0.018
407	0.62	0	0.07	0.027
408	1.72	0	0.07	0.012
409	2.13	0	0.07	0.015
410	1.21	0	0.07	0.007
411	1.35	0	0.07	0.030
412	1.33	0	0.07	0.022
413	1.28	0	0.07	0.024
414	0.97	0	0.07	0.016
415	0.66	0	0.07	0.015
416	1.65	0	0.07	0.013
417	0.55	0	0.07	0.011
418	0.57	0	0.07	0.011
419	0.21	0	0.07	0.018
420	1.00	0	0.07	0.015
421	1.25	0	0.07	0.026
422	0.87	0	0.07	0.015
423	1.00	0	0.07	0.008
424	0.79	0	0.07	0.016
425	2.31	0	0.07	0.009
426	1.00	0	0.07	0.005
501	2.03	0	0.07	0.010
502	2.62	0	0.07	0.006
503	0.56	0	0.07	0.005
504	1.46	0	0.07	0.005
505	4.78	0	0.07	0.007
506	2.93	0	0.07	0.006
507	3.35	0	0.07	0.004
508	3.88	0	0.07	0.006
509	3.46	0	0.07	0.006
510	1.80	0	0.07	0.032

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
511	1.23	0	0.07	0.031
512	3.76	0	0.07	0.015
513	6.14	0	0.07	0.036
514	1.96	0	0.07	0.007
601	0.32	0	0.07	0.012
602	3.63	0	0.07	0.008
603	1.13	0	0.07	0.005
604	1.49	0	0.07	0.011
605	2.43	0	0.07	0.006
606	2.29	0	0.07	0.007
607	0.69	0	0.07	0.004
608	2.44	0	0.07	0.005
609	2.66	0	0.07	0.006
610	3.38	0	0.07	0.006
611	2.88	0	0.07	0.007
612	2.47	0	0.07	0.006
613	0.96	0	0.07	0.009
614	0.21	0	0.07	0.002
615	2.21	0	0.07	0.047
618	0.32	0	0.07	0.003
619	0.43	0	0.07	0.009
620	2.77	0	0.07	0.008
621	3.18	0	0.07	0.009
701	1.23	0	0.07	0.005
702	4.86	0	0.07	0.007
703	1.80	0	0.07	0.005
704	1.35	0	0.07	0.006
705	1.22	0	0.07	0.012
706	2.13	0	0.07	0.005
707	1.84	0	0.07	0.007
708	2.27	0	0.07	0.007
711	4.15	0	0.07	0.008
712	0.16	0	0.07	0.006
713	1.27	0	0.07	0.014
714	0.55	0	0.07	0.002

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
715	1.15	0	0.07	0.006
716	1.95	0	0.07	0.011
717	1.89	0	0.07	0.009
718	2.25	0	0.07	0.008
719	0.73	0	0.07	0.007
720	1.69	0	0.07	0.005
721	0.77	0	0.07	0.004
722	2.29	0	0.07	0.009
723	0.36	0	0.07	0.002
724	0.88	0	0.07	0.008
725	1.67	0	0.07	0.007
726	1.07	0	0.07	0.007
727	0.61	0	0.07	0.008
728	0.92	0	0.07	0.012
729	0.52	0	0.07	0.004
730	0.46	0	0.07	0.012
801	6.29	0	0.07	0.011
802	3.02	0	0.07	0.013
803	7.28	0	0.07	0.009
804	6.31	0	0.07	0.009
805	5.39	0	0.07	0.075
806	4.86	0	0.07	0.108
807	3.45	0	0.07	0.040
808	3.68	0	0.07	0.107
809	5.80	0	0.07	0.044
810	4.62	0	0.07	0.106
811	3.55	0	0.07	0.008
812	2.30	0	0.07	0.059
813	1.92	0	0.07	0.021
814	7.10	0	0.07	0.074
815	11.57	0	0.07	0.015
816	2.31	0	0.07	0.104
817	4.75	0	0.07	0.072
818	3.83	0	0.07	0.076
819	0.74	0	0.07	0.010

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
820	3.15	0	0.07	0.039
821	0.75	0	0.07	0.005
822	4.47	0	0.07	0.062
824	1.24	0	0.07	0.010
825	17.80	0	0.07	0.004
826	2.94	0	0.07	0.014
827	2.01	0	0.07	0.008
828	8.08	0	0.07	0.019
829	12.06	0	0.07	0.015
830	10.24	0	0.07	0.009
831	4.87	0	0.07	0.030
832	2.36	0	0.07	0.039
833	2.38	0	0.07	0.070
834	1.62	0	0.07	0.034
835	2.01	0	0.07	0.045
901	2.16	0	0.07	0.037
902	4.27	0	0.07	0.034
903	0.86	0	0.07	0.031
904	15.68	0	0.07	0.028
905	4.65	0	0.07	0.041
906	3.15	0	0.07	0.034
907	0.56	0	0.07	0.006
908	0.42	0	0.07	0.010
909	3.92	0	0.07	0.027
910	2.02	0	0.07	0.005
911	0.34	0	0.07	0.005
912	4.87	0	0.07	0.022
914	0.39	0	0.07	0.004
915	8.00	0	0.07	0.022
916	3.12	0	0.07	0.022
917	5.05	0	0.07	0.006
918	5.11	0	0.07	0.005
919	7.07	0	0.07	0.030
920	2.75	0	0.07	0.007
921	3.07	0	0.07	0.011

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
922	0.80	0	0.07	0.002
923	3.09	0	0.07	0.007
924	4.33	0	0.07	0.005
925	2.19	0	0.07	0.002
1031	0.81	0.5	0.07	0.012
1111	0.94	0.5	0.07	0.021
3161	1.32	0	0.07	0.048
3301	1.25	0	0.07	0.067
8131	1.06	0	0.07	0.021
8211	0.76	0	0.07	0.026

A.1 SPECULATION CREEK (SPC) CATCHMENT

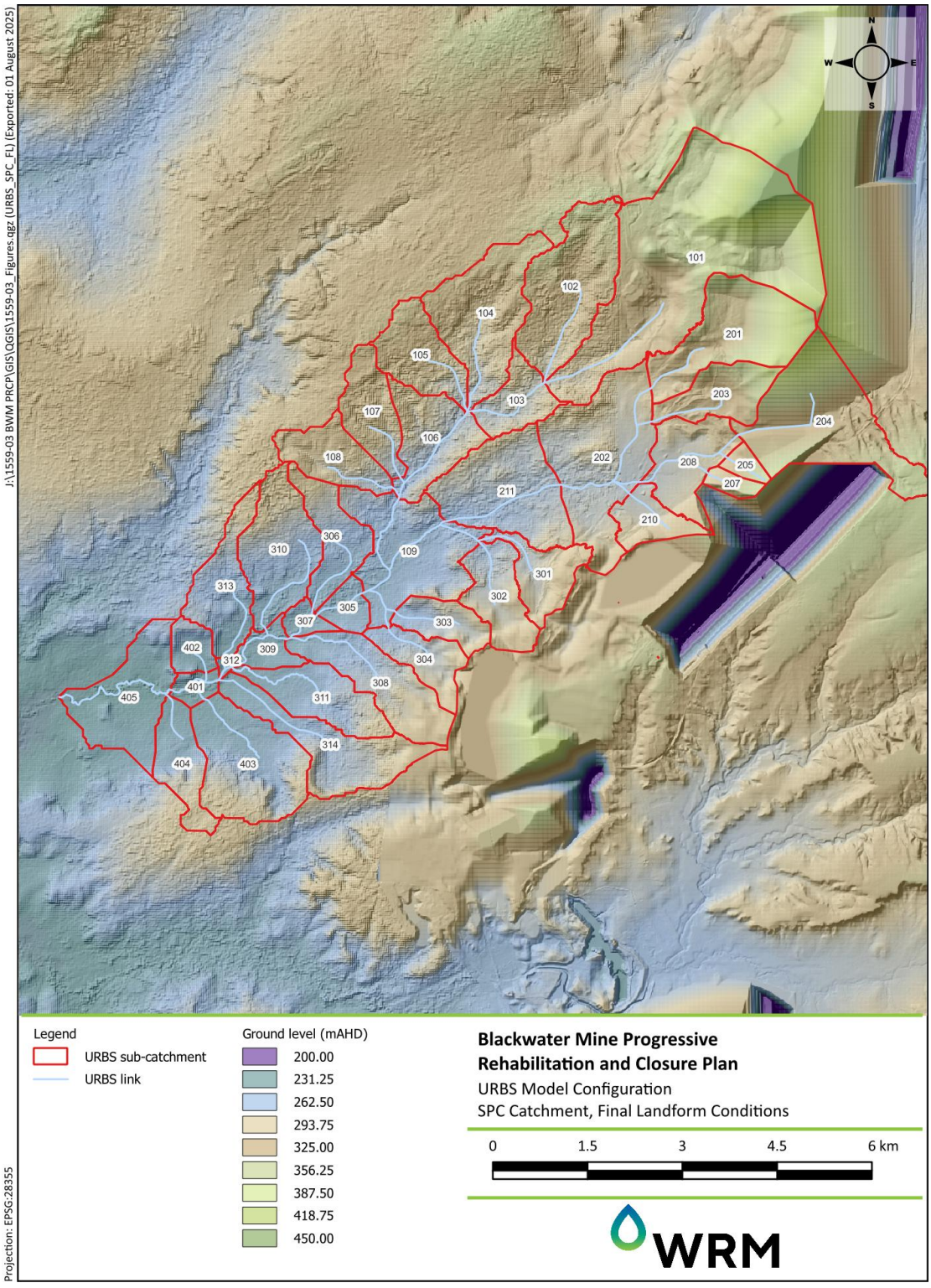


Figure A.5 URBS model configuration, Speculation Creek catchment, final landform conditions

Table A.5 URBS model subcatchment parameters, Speculation Creek catchment

ID	Total Area (km2)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	8.37	0	0.070	0.025
102	2.89	0	0.100	0.018
103	1.00	0	0.100	0.016
104	2.70	0	0.100	0.016
105	1.47	0	0.100	0.028
106	1.69	0	0.100	0.017
107	1.31	0	0.100	0.027
108	1.27	0	0.100	0.027
109	2.90	0	0.070	0.009
201	2.74	0	0.070	0.032
202	3.60	0	0.100	0.007
203	1.26	0	0.070	0.031
204	3.55	0	0.070	0.020
205	0.27	0	0.070	0.110
207	0.28	0	0.070	0.099
208	1.56	0	0.100	0.011
210	0.83	0	0.070	0.033
211	2.77	0	0.100	0.011
301	1.10	0	0.080	0.017
302	1.35	0	0.100	0.022
303	0.87	0	0.080	0.024
304	1.00	0	0.080	0.022
305	0.49	0	0.070	0.009
306	1.32	0	0.070	0.010
307	0.31	0	0.070	0.009
308	1.96	0	0.080	0.019
309	0.53	0	0.080	0.005
310	2.18	0	0.100	0.017
311	1.56	0	0.100	0.015
312	0.07	0	0.070	0.006
313	1.57	0	0.070	0.013
314	2.19	0	0.100	0.012
401	0.33	0	0.070	0.014
402	0.52	0	0.070	0.024

ID	Total Area (km2)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
403	2.73	0	0.070	0.019
404	1.19	0	0.070	0.025
405	2.24	0	0.070	0.007

A.5 SIRIUS CREEK (SRC) CATCHMENT

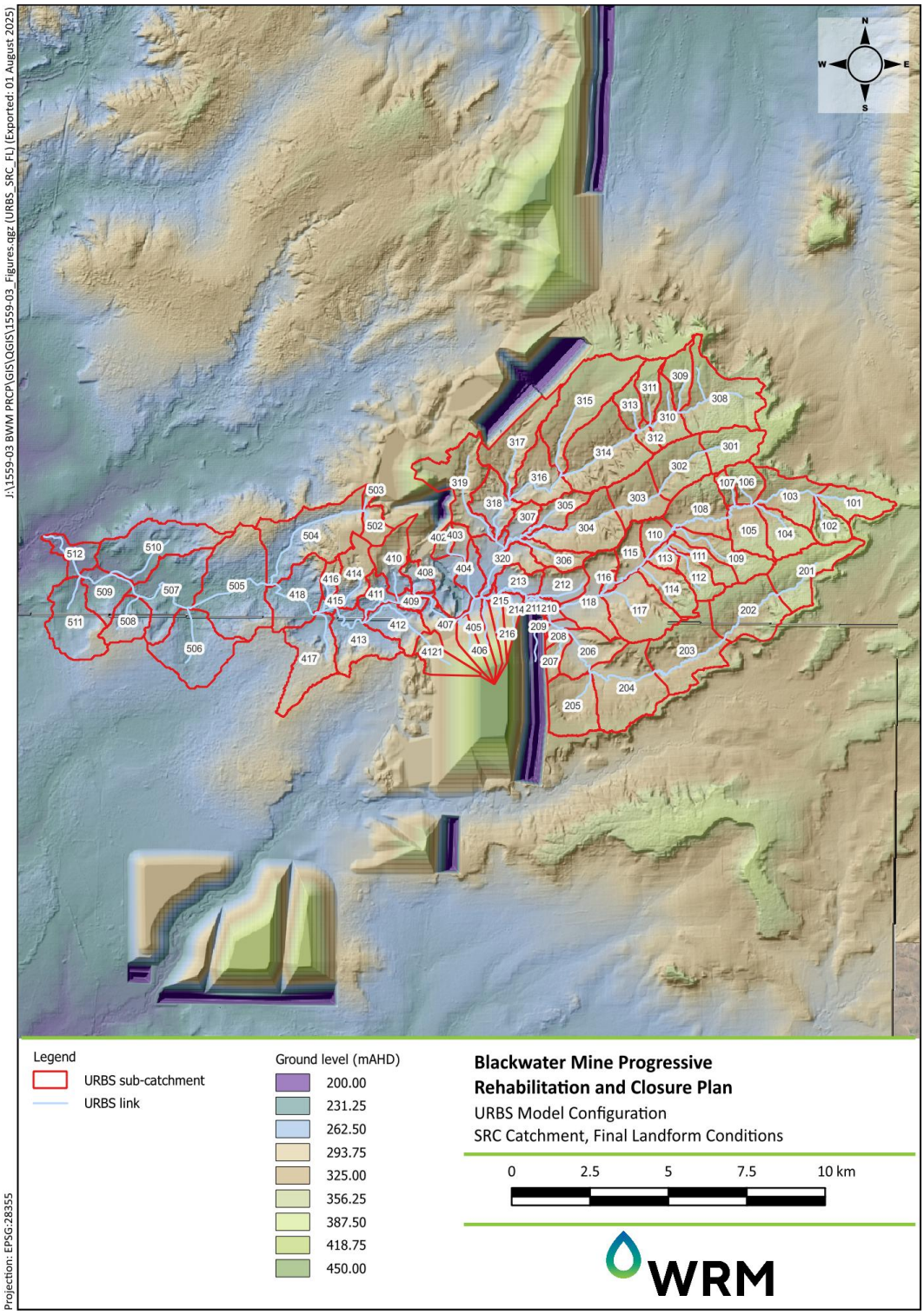


Figure A.6 URBS model configuration, Sirius Creek catchment, final landform conditions

Table A.6 URBS catchment parameters of the SRC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.70	0	0.045	0.016
102	1.18	0	0.045	0.016
103	2.37	0	0.045	0.016
104	1.66	0	0.045	0.024
105	1.75	0	0.045	0.027
106	1.13	0	0.045	0.039
107	0.48	0	0.045	0.048
108	2.73	0	0.045	0.019
109	1.92	0	0.045	0.017
110	0.88	0	0.045	0.010
111	1.09	0	0.045	0.022
112	1.22	0	0.045	0.030
113	0.56	0	0.045	0.013
114	1.67	0	0.045	0.025
115	1.17	0	0.045	0.009
116	0.22	0	0.045	0.015
117	3.37	0	0.045	0.025
118	2.53	0	0.045	0.013
201	2.99	0	0.045	0.015
202	3.67	0	0.045	0.010
203	4.14	0	0.045	0.016
204	4.50	0	0.045	0.017
205	2.75	0	0.045	0.022
206	2.04	0	0.045	0.017
207	0.64	0	0.045	0.023
208	0.49	0	0.045	0.027
209	0.07	0	0.045	0.028
210	0.21	0	0.045	0.014
211	0.35	0	0.045	0.005
212	1.40	0	0.045	0.020
213	1.11	0	0.045	0.016
214	0.79	0	0.045	0.061
215	0.13	0	0.045	0.007
216	0.60	0	0.045	0.085

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
217	0.62	0	0.045	0.081
301	2.00	0	0.045	0.015
302	2.56	0	0.045	0.014
303	2.28	0	0.045	0.031
304	3.32	0	0.045	0.011
305	1.21	0	0.045	0.013
306	1.09	0	0.045	0.022
307	0.88	0	0.045	0.015
308	4.36	0	0.045	0.012
309	1.31	0	0.045	0.028
310	1.47	0	0.045	0.024
311	1.18	0	0.045	0.032
312	0.45	0	0.045	0.053
313	0.99	0	0.045	0.033
314	4.85	0	0.045	0.014
315	4.80	0	0.045	0.019
316	2.33	0	0.045	0.021
317	2.84	0	0.045	0.018
318	1.76	0	0.045	0.012
319	3.55	0	0.045	0.016
320	1.98	0	0.045	0.008
402	0.48	0	0.045	0.022
403	0.50	0	0.045	0.023
404	0.91	0	0.045	0.004
405	0.86	0	0.045	0.073
406	0.87	0	0.045	0.091
407	1.52	0	0.045	0.034
408	0.63	0	0.045	0.006
409	0.43	0	0.045	0.017
410	1.84	0	0.045	0.030
411	0.90	0	0.045	0.011
412	1.82	0	0.045	0.010
413	2.61	0	0.045	0.005
414	1.90	0	0.045	0.016
415	0.22	0	0.045	0.032

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
416	0.59	0	0.045	0.037
417	3.27	0	0.045	0.020
418	2.92	0	0.045	0.021
502	0.85	0	0.045	0.040
503	0.19	0	0.045	0.036
504	5.27	0	0.045	0.012
505	6.15	0	0.045	0.006
506	4.05	0	0.045	0.017
507	3.90	0	0.045	0.007
508	1.60	0	0.045	0.034
509	1.75	0	0.045	0.019
510	4.43	0	0.045	0.008
511	3.38	0	0.045	0.015
512	1.25	0	0.045	0.003
4121	1.44	0	0.045	0.064

A.6 ROCKLAND CREEK (RLC) CATCHMENT

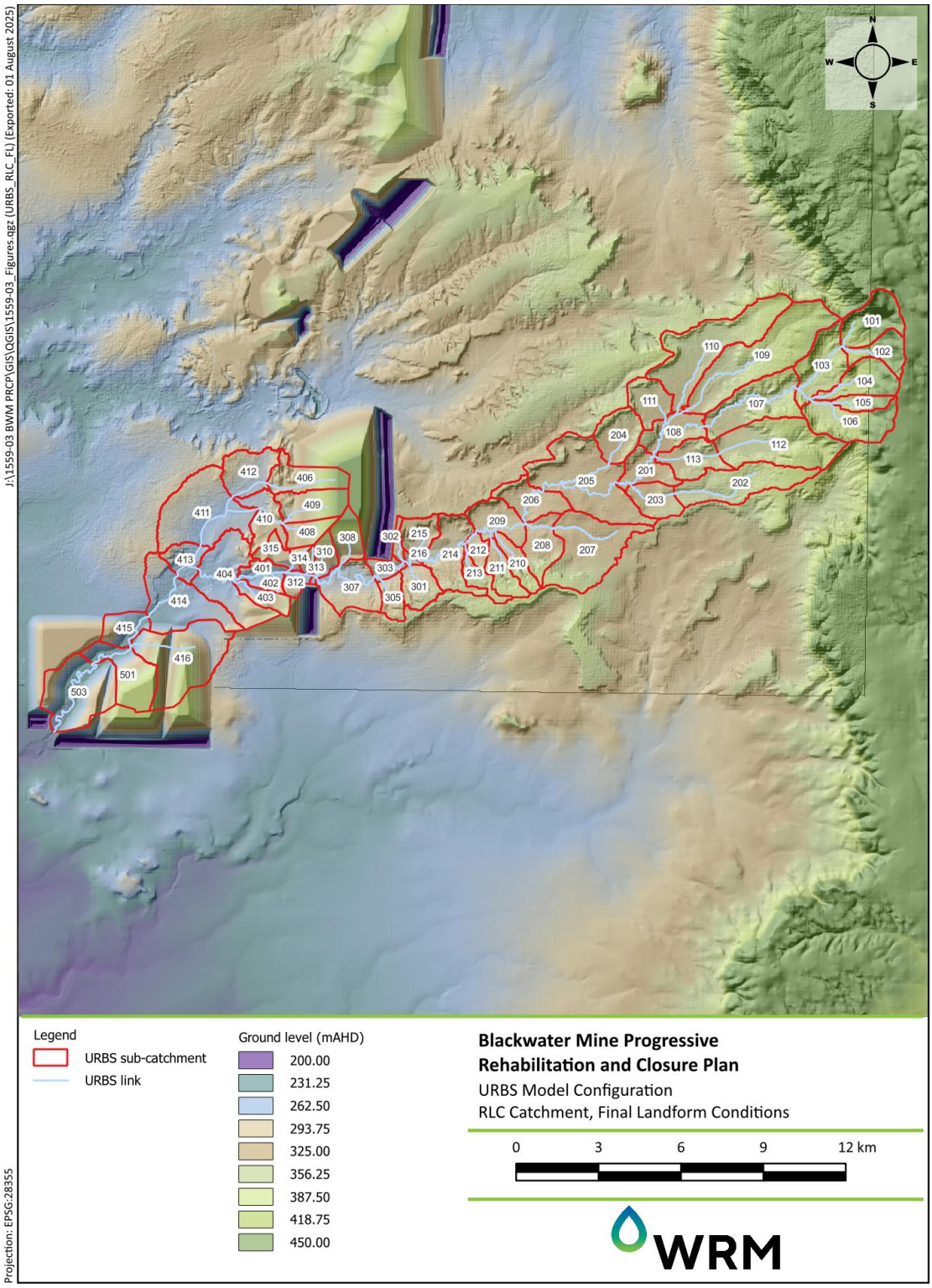


Figure A.7 URBS model configuration, Rockland Creek catchment, final landform conditions

Table A.7 URBS model subcatchment parameters, Rockland Creek catchment

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	3.11	0	0.080	0.086
102	1.89	0	0.080	0.058
103	3.55	0	0.070	0.022
104	2.73	0	0.080	0.040
105	1.05	0	0.080	0.046
106	3.77	0	0.080	0.023
107	4.87	0	0.070	0.010
108	2.46	0	0.070	0.008
109	8.51	0	0.070	0.011
110	7.54	0	0.070	0.010
111	2.19	0	0.070	0.015
112	6.42	0	0.070	0.014
113	2.49	0	0.070	0.010
201	2.00	0	0.070	0.009
202	4.84	0	0.080	0.012
203	1.99	0	0.070	0.014
204	2.59	0	0.070	0.016
205	7.98	0	0.070	0.010
206	2.57	0	0.070	0.010
207	6.24	0	0.070	0.009
208	2.46	0	0.070	0.018
209	2.48	0	0.070	0.008
210	1.37	0	0.080	0.033
211	1.66	0	0.080	0.033
212	0.75	0	0.070	0.035
213	1.16	0	0.080	0.039
214	3.65	0	0.080	0.025
215	1.56	0	0.070	0.026
216	0.23	0	0.070	0.035
301	1.82	0	0.080	0.039
302	0.44	0	0.070	0.043
303	0.81	0	0.070	0.009
305	1.23	0	0.070	0.036
307	3.29	0	0.070	0.011

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
308	1.75	0	0.070	0.086
310	1.13	0	0.070	0.065
312	0.74	0	0.070	0.043
313	0.41	0	0.070	0.076
314	0.27	0	0.070	0.064
315	1.08	0	0.070	0.035
401	1.36	0	0.070	0.011
402	0.16	0	0.070	0.108
403	1.19	0	0.070	0.033
404	4.98	0	0.070	0.026
406	2.66	0	0.070	0.064
408	1.38	0	0.070	0.070
409	2.66	0	0.070	0.069
410	2.22	0	0.070	0.011
411	6.86	0	0.070	0.012
412	2.78	0	0.070	0.006
413	1.56	0	0.070	0.023
414	5.16	0	0.070	0.035
415	1.73	0	0.070	0.022
416	6.88	0	0.070	0.028
501	3.59	0	0.070	0.040
503	5.69	0	0.070	0.031

APPENDIX B TUFLOW MODEL CONFIGURATION

B.1 MODEL CONFIGURATION

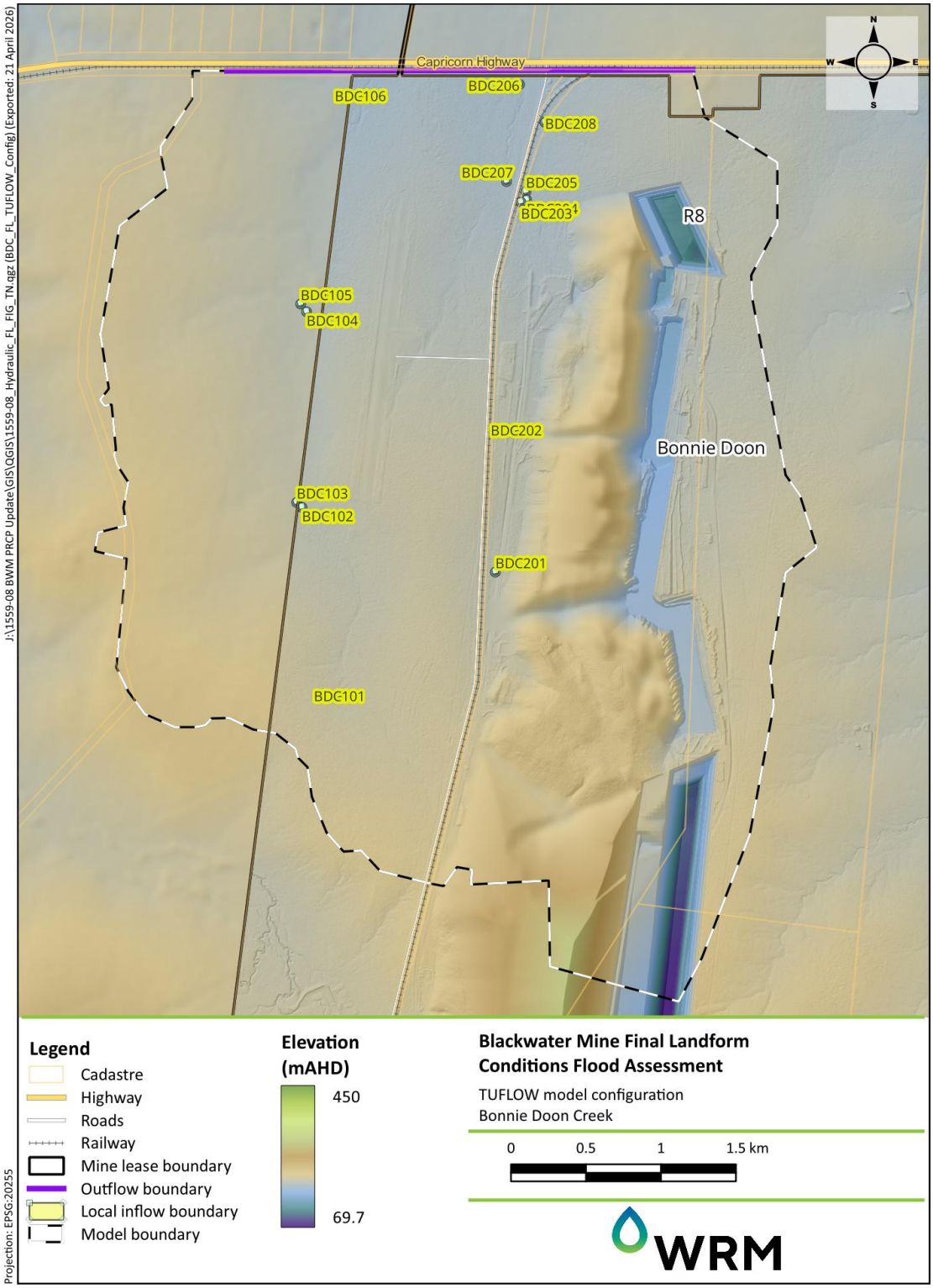


Figure B.1 Bonnie Doon Creek TUFLOW model configuration, final landform conditions

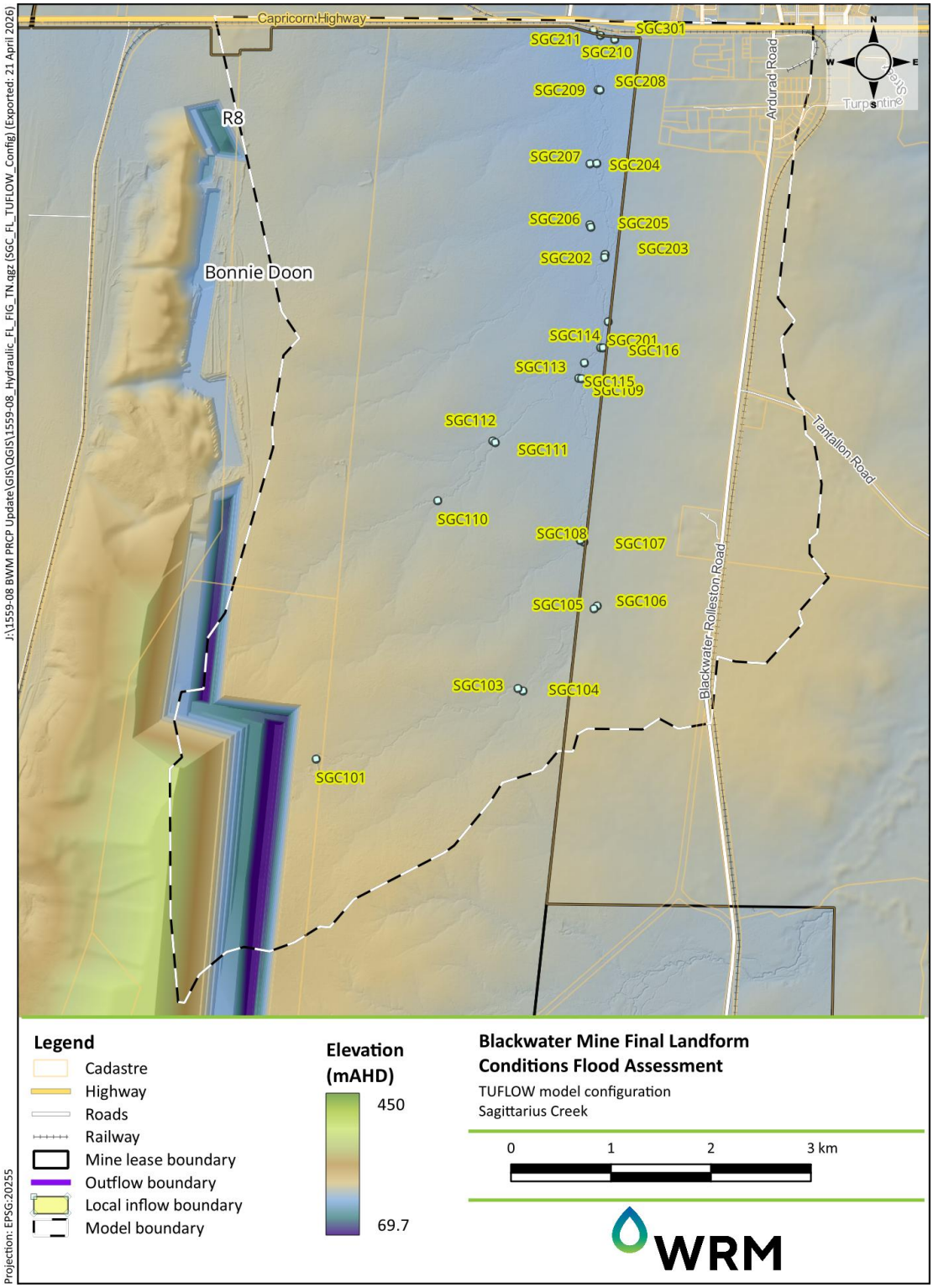


Figure B.2 Sagittarius Creek TUFLOW model configuration, final landform conditions

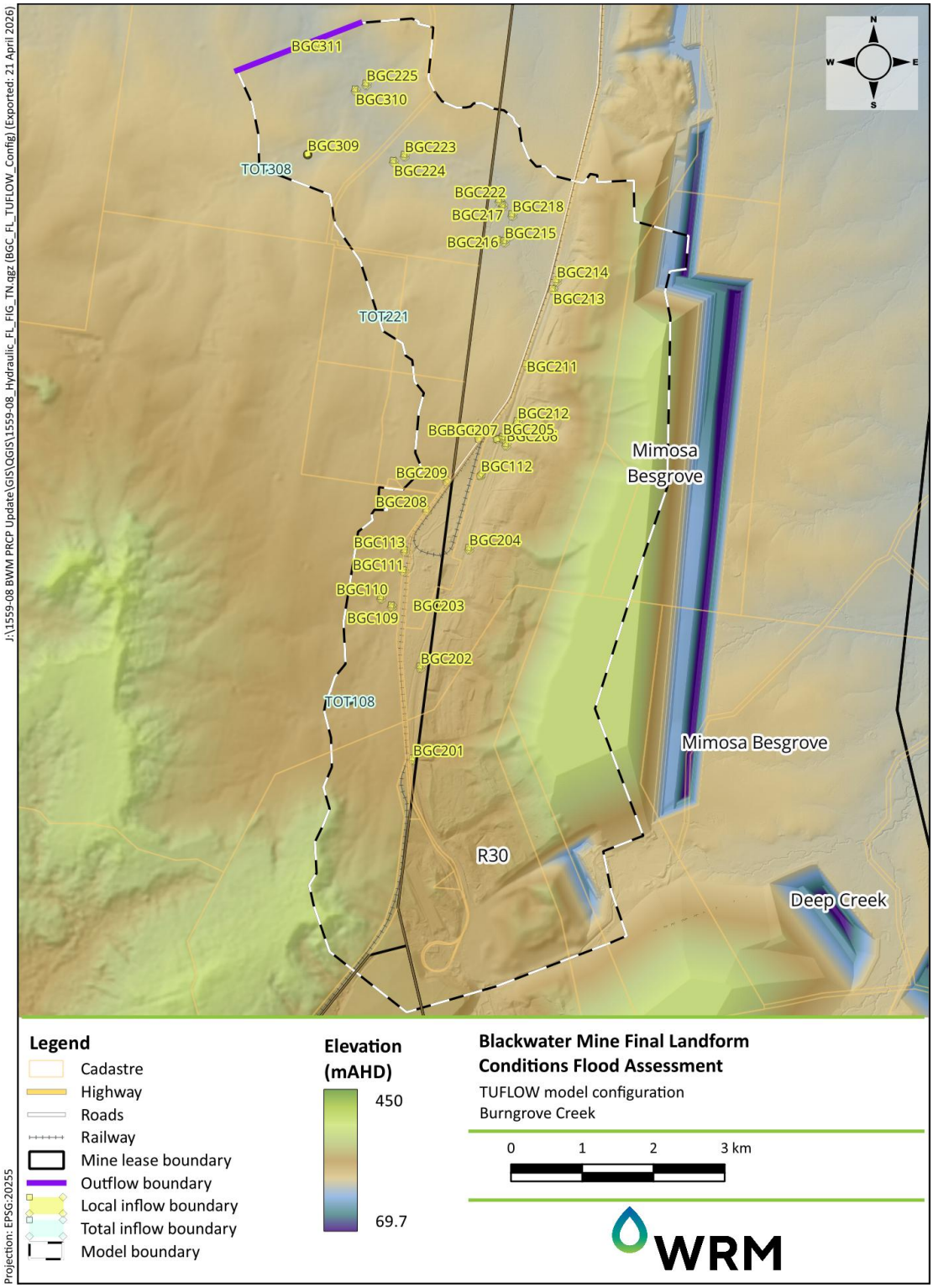


Figure B.3 Burngrove Creek TUFLOW model configuration, final landform conditions

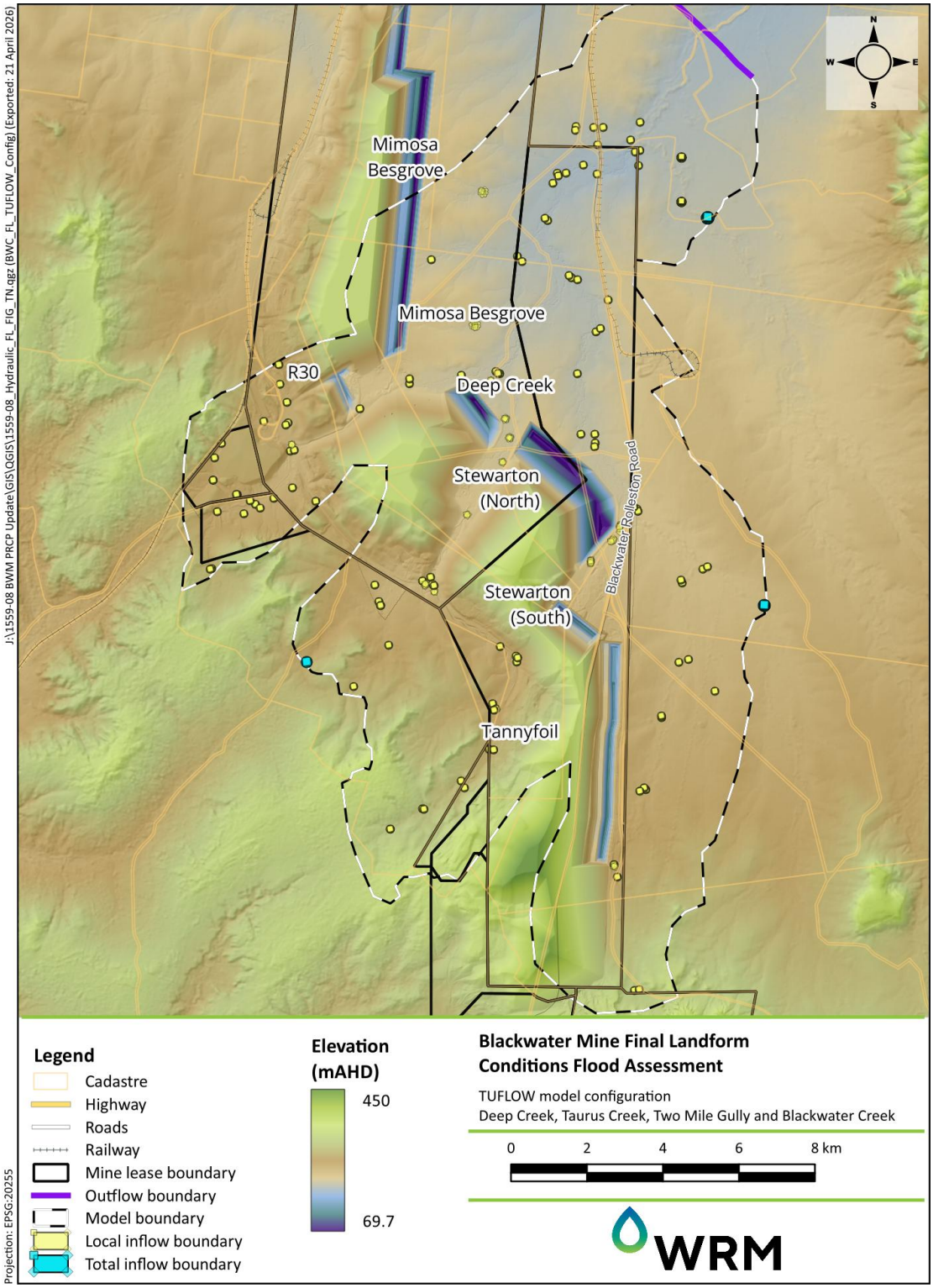


Figure B.4 Blackwater Creek (including Deep Creek, Taurus Creek and Two Mile Gully) TUFLOW model configuration, final landform conditions

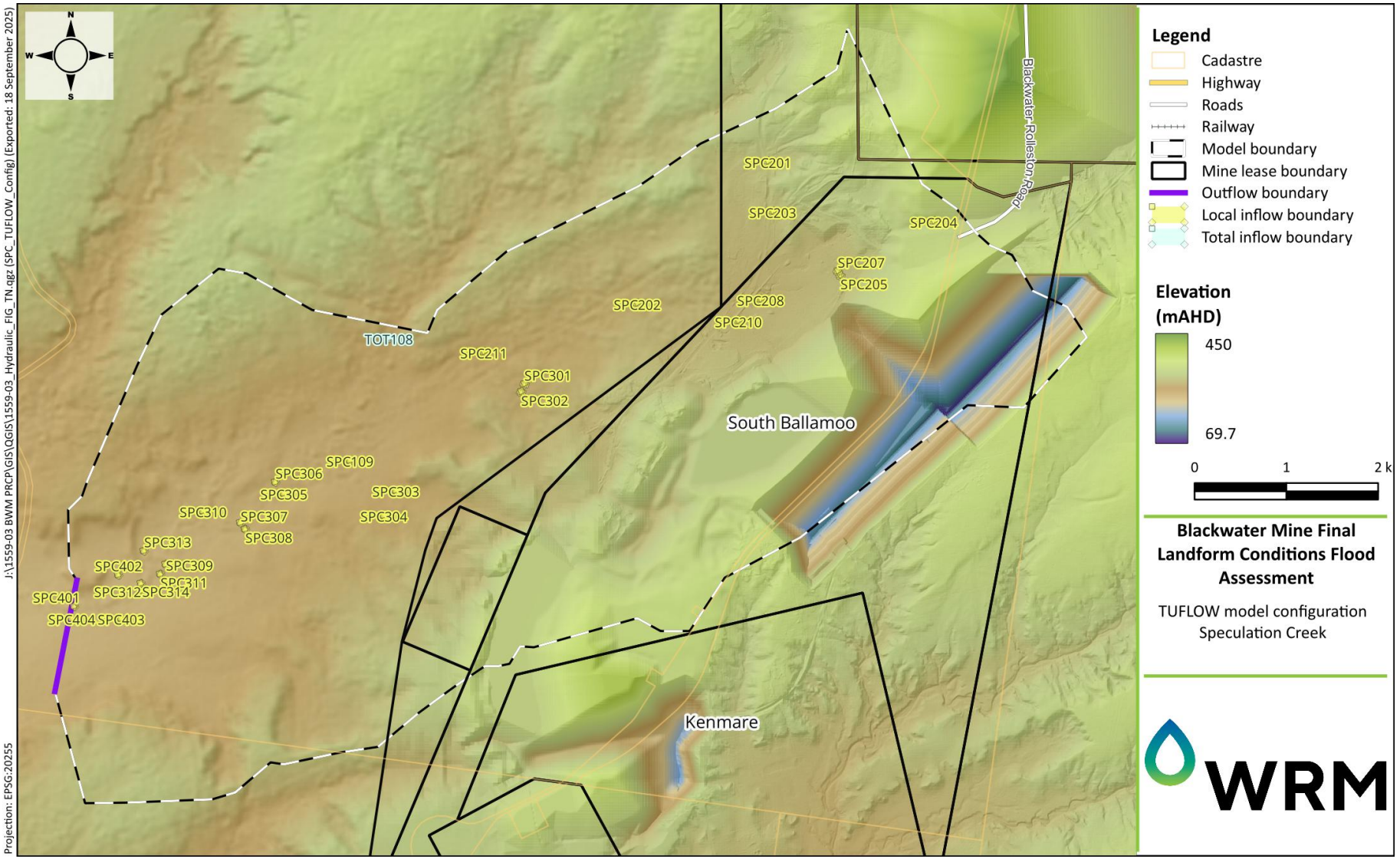


Figure B.5 Speculation Creek TUFLOW model configuration, final landform conditions

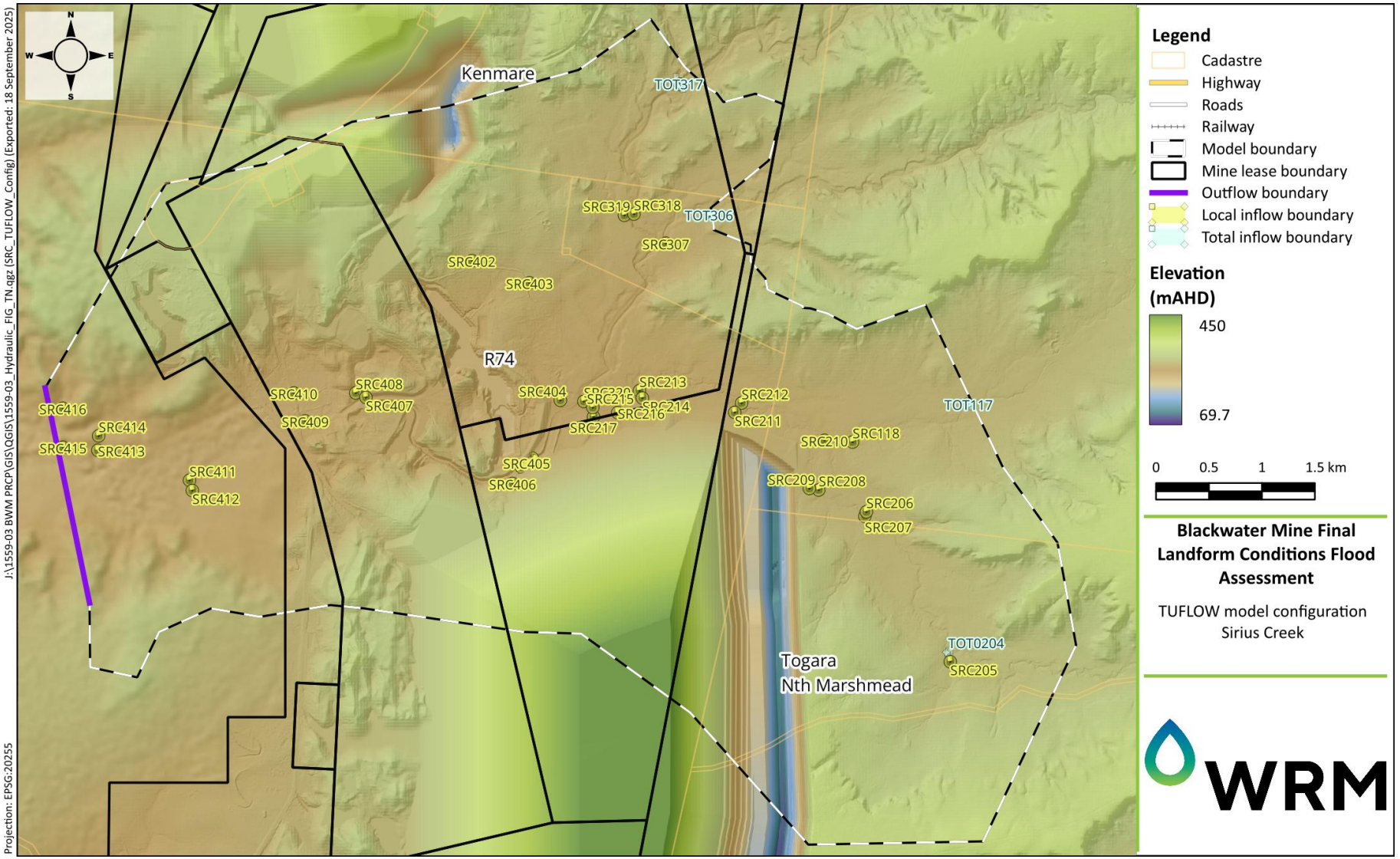


Figure B.6 Sirius Creek TUFLOW model configuration, final landform conditions

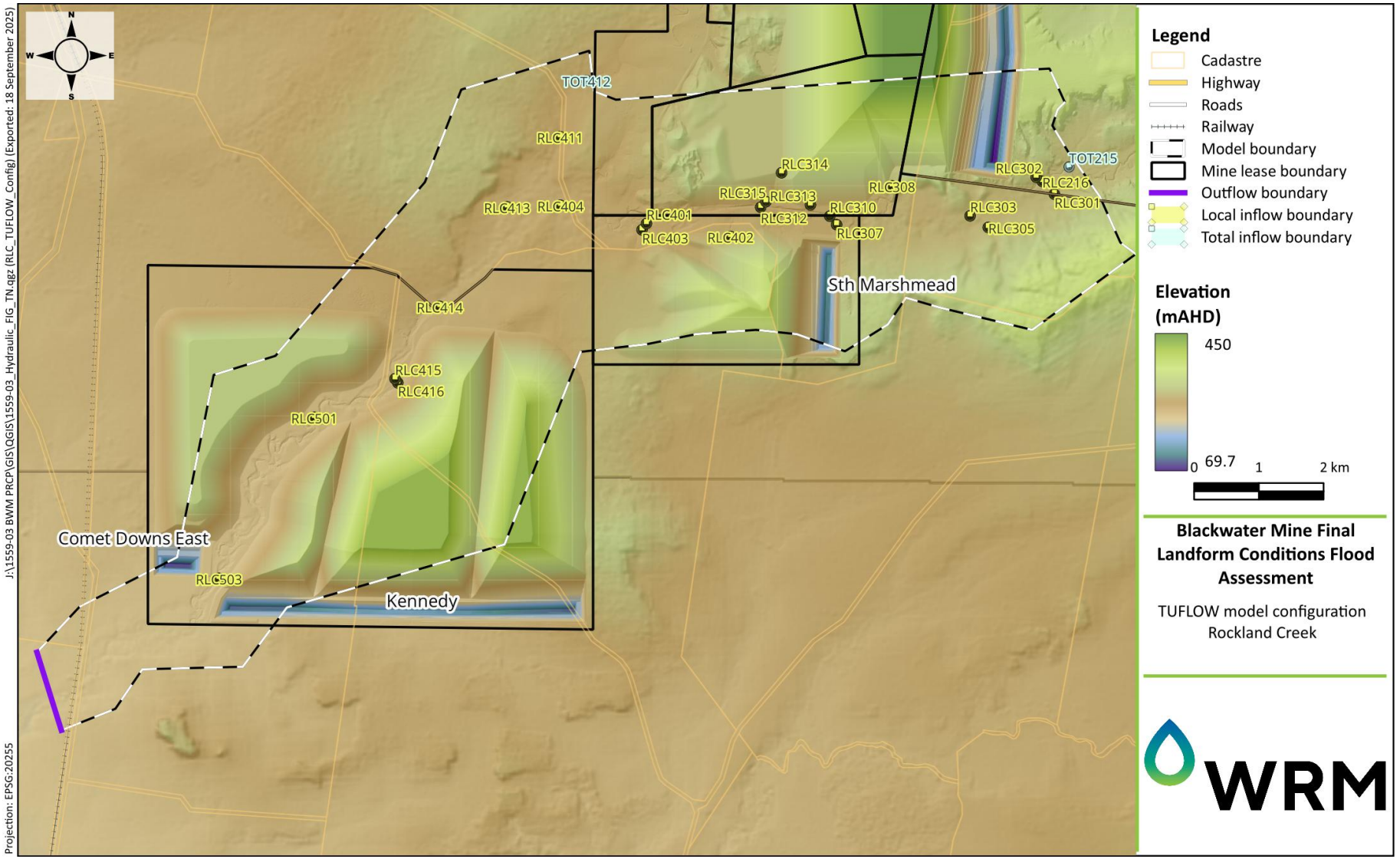


Figure B.7 Rockland Creek TUFLOW model configuration, final landform conditions

B.2 HYDRAULIC STRUTURES

Table B.1 Bonnie Doon Creek TUFLOW model culvert details

ID	Type	Upstream IL (mAHD)	Downstream IL (mAHD)	Width/ Diameter (m)	Height (m)	Barrel (No.)
649	RCP	207.55	207.45	0.6	0	1
650	RCP	196.039	195.63	0.6	0	3
69379b	RCP	182.4	182.3	1.3	0	7
649_Rail	RCP	207.4	207.35	0.6	0	1
May222	RCP	192.9	192.8	0.6	0	1
6937a	RBCP	182.5	182.4	3	3	5

Table B.2 Burngrove Creek TUFLOW model culvert details

ID	Type	Upstream IL (mAHD)	Downstream IL (mAHD)	Width/ Diameter (m)	Height (m)	Barrel (No.)
1003	RCP	264.4	263.8	0.9	0	8
1003a	RCP	264.2	263.1	0.9	0	8
440	RCP	247.1	245.4	0.9	0	1
442	RCP	243.577	243.256	1.2	0	2
647	RCP	224.02	222.65	0.6	0	1
648	RCP	221.61	221.043	0.6	0	1
652	RCP	226.98	226.56	0.6	0	1
69379	RCP	202.86	202.45	1.3	0	7
72793	RCP	225.007	224.921	0.9	3	2
727931	RCP	225.007	224.921	0.9	0	2
73301a	RCP	226.86	226.36	1	0	3
73307	RCP	226.86	226.36	1.3	0	2
999a	RCP	261.3	260.69	0.9	0	8
Assumed_02	RCP	252.02	251.96	1.3	0	2
69386	RBCP	203.01	202.85	3	3	7
69489	RBCP	226.6	225.9	2	1.8	4
72792	RBCP	223.423	223.054	1.2	0.9	2
727921	RBCP	223.423	223.054	1.2	0.9	1
99a	RBCP	225.87	225.56	1.2	0.9	3

Table B.3 Blackwater Creek TUFLOW model culvert details

ID	Type	Upstream IL (mAHD)	Downstream IL (mAHD)	Width/ Diameter (m)	Height (m)	Barrel (No.)
440	RCP	247.1	245.4	0.9		1
441	RCP	243.341	243.399	1.1		3
442	RCP	243.577	243.256	1.2		2
1003	RCP	264.4	263.8	0.9		8
1013	RCP	247.515	247.246	0.9		1
1015	RCP	245.442	245.1	0.9		1
1016	RCP	243.821	243.88	0.9		1
1017	RCP	243.393	243.221	0.9		1
1018	RCP	245.882	245.556	0.9		1
1019	RCP	245.354	244.718	0.9		1
1020	RCP	236.93	236.707	0.45		1
1021	RCP	235.552	235.323	0.45		1
1022	RCP	230.409	230.269	0.75		2
1023	RCP	230.058	229.816	0.75		2
1003a	RCP	264.2	263.1	0.9		8
Assumed	RCP	230.15	230.046	0.6		1
Assumed_02	RCP	252.02	251.96	1.3		2
TMR_36587	RCP	204.88	204.5	1.8		6
TMR_24546	RBCP	180.09	180.06	3.05	2.74	2

APPENDIX C FINAL LANFORM CONDITIONS FLOOD MAPS

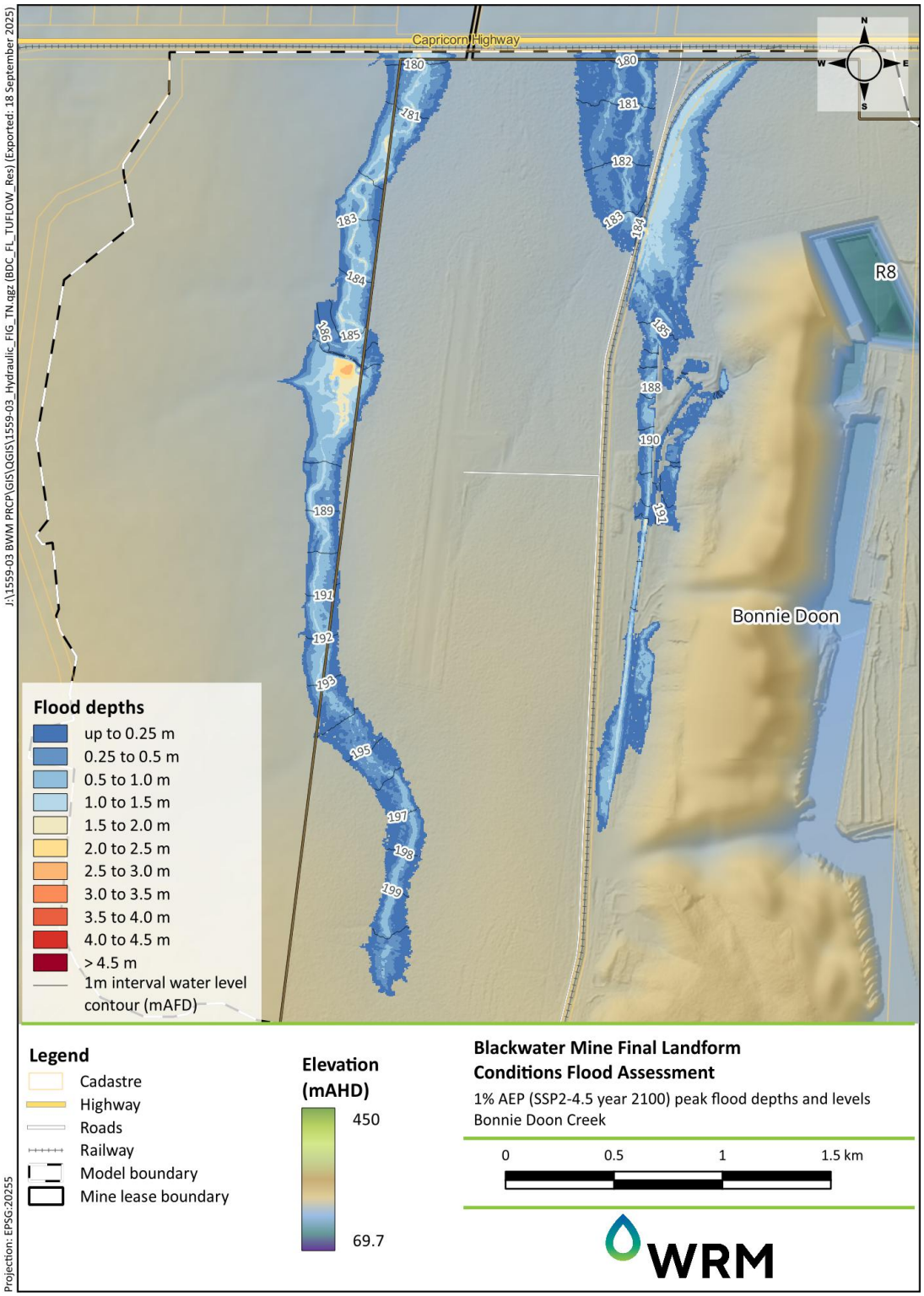


Figure C.1 Final landform conditions 1% AEP peak flood depths, levels and extents, Bonnie Doon Creek

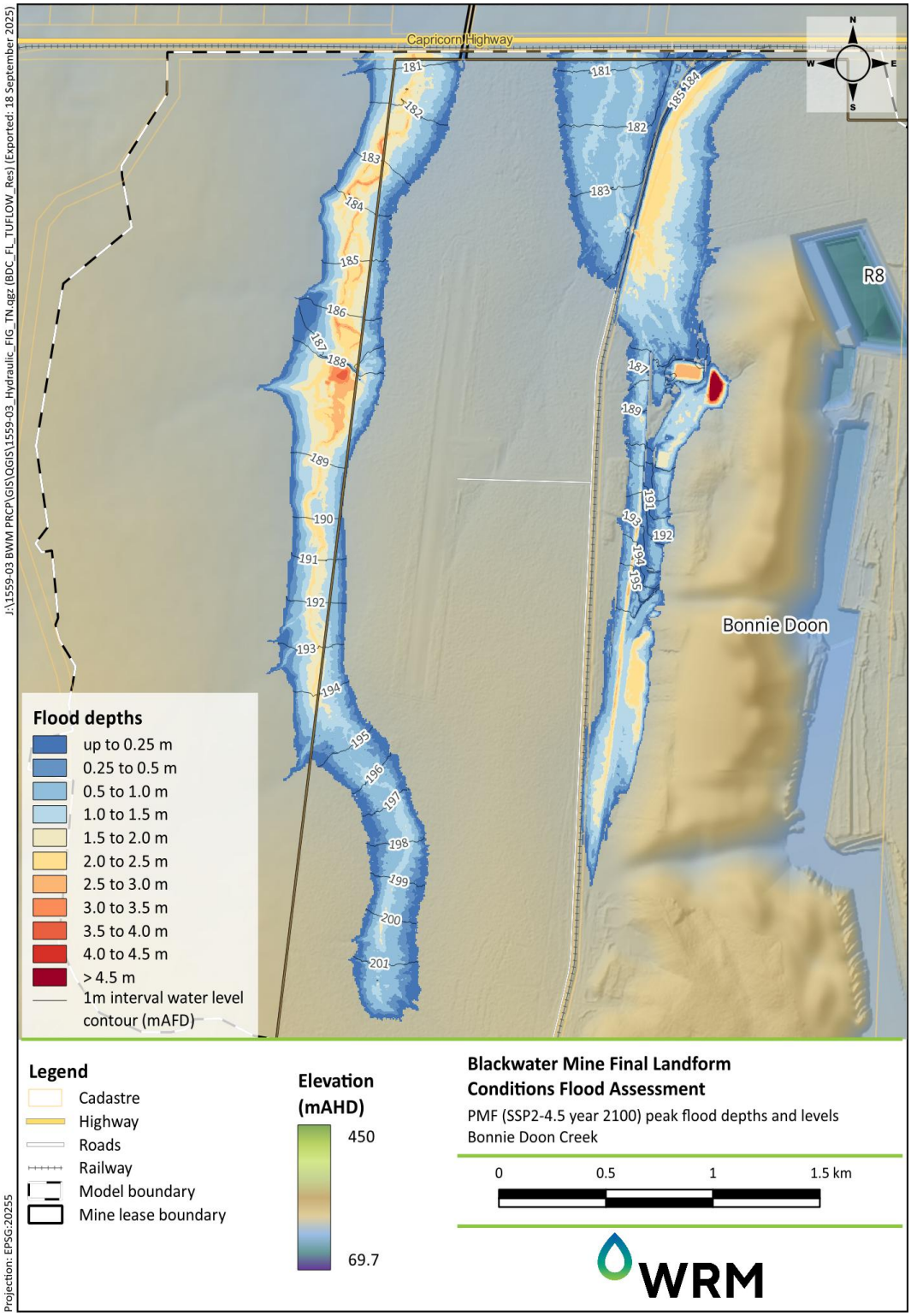


Figure C.2 Final landform conditions PMF peak flood depths, levels and extents, Bonnie Doon Creek

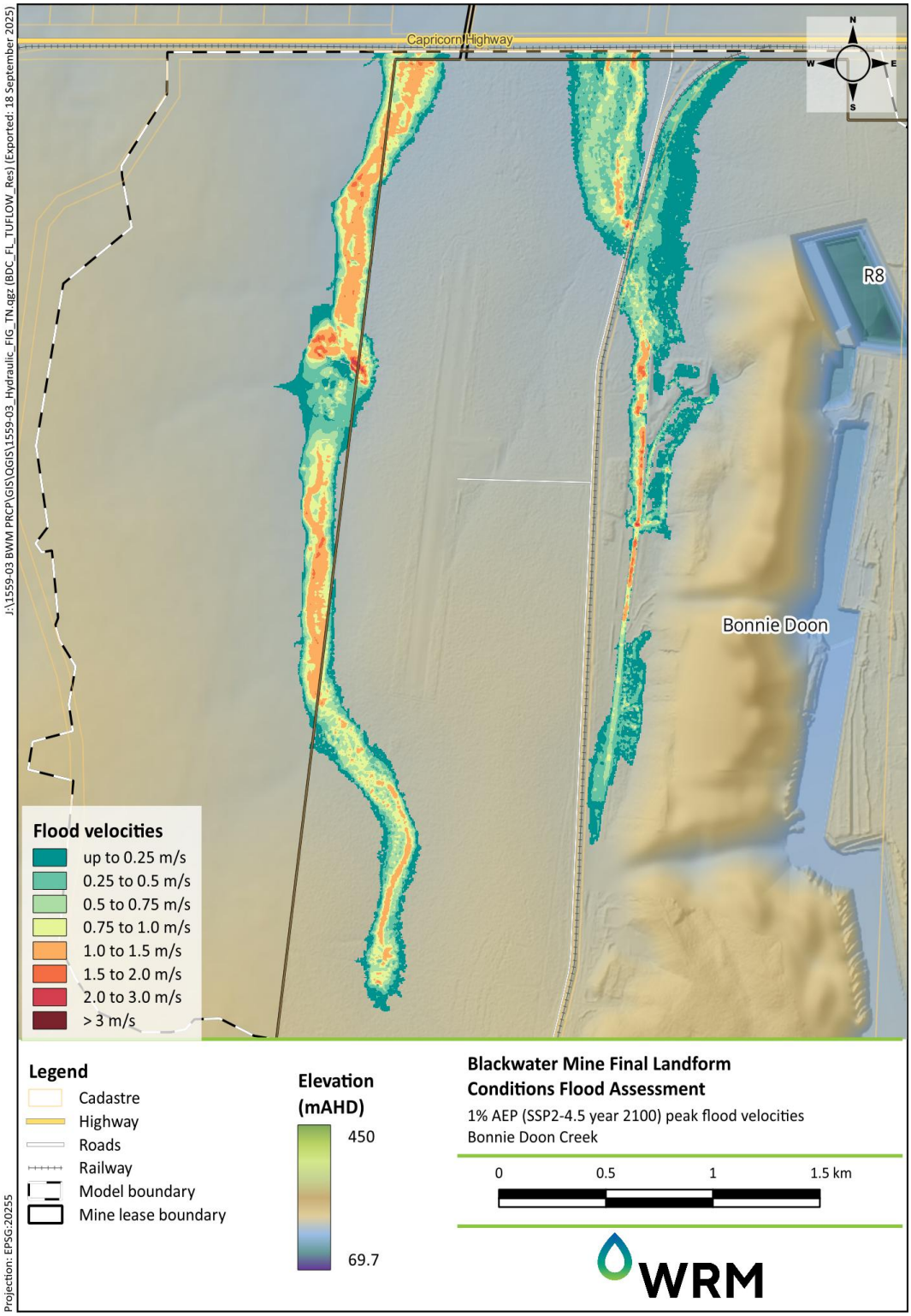


Figure C.3 Final landform conditions 1% AEP peak flood velocities, Bonnie Doon Creek

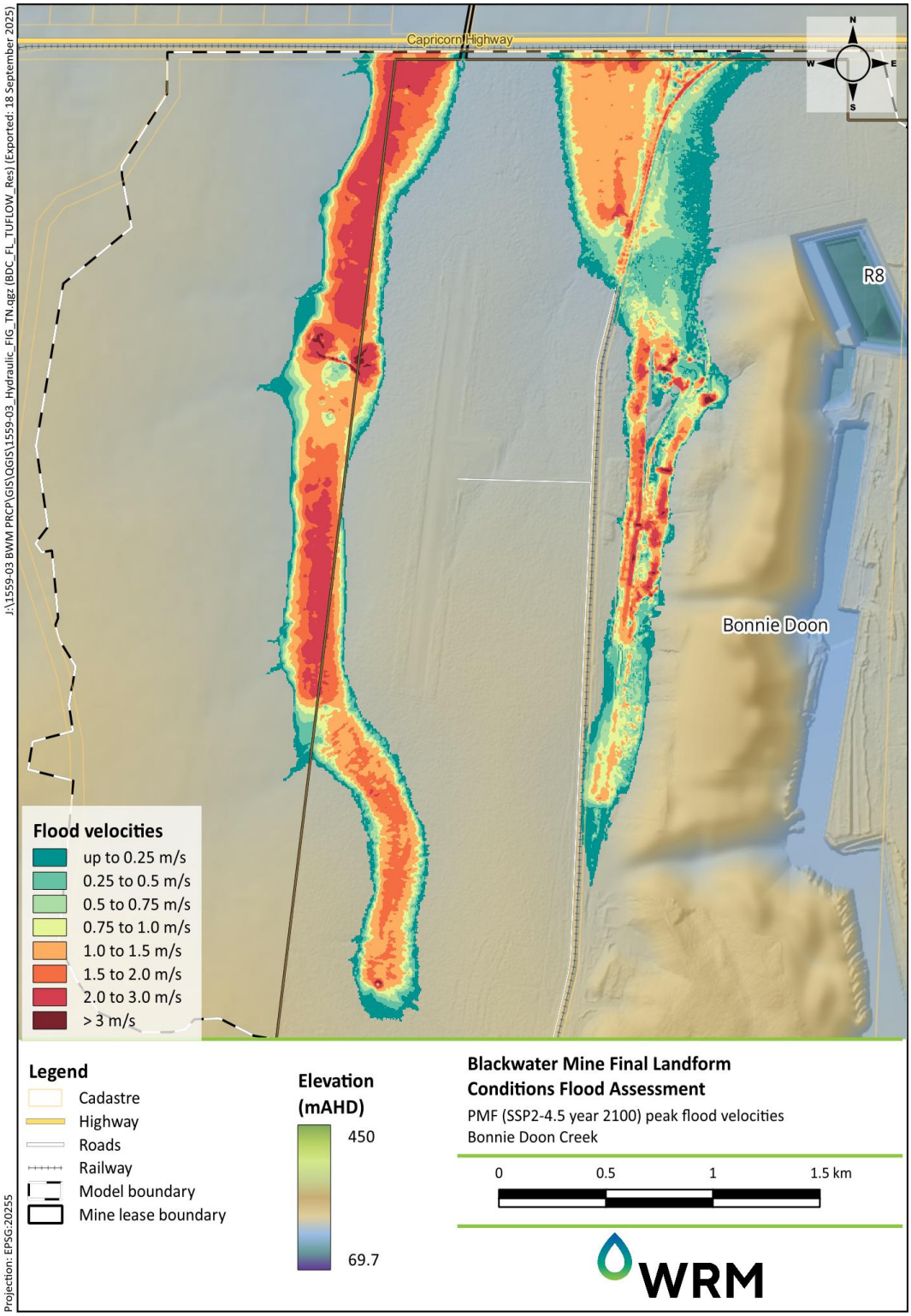


Figure C.4 Final landform conditions PMF peak flood velocities, Bonnie Doon Creek

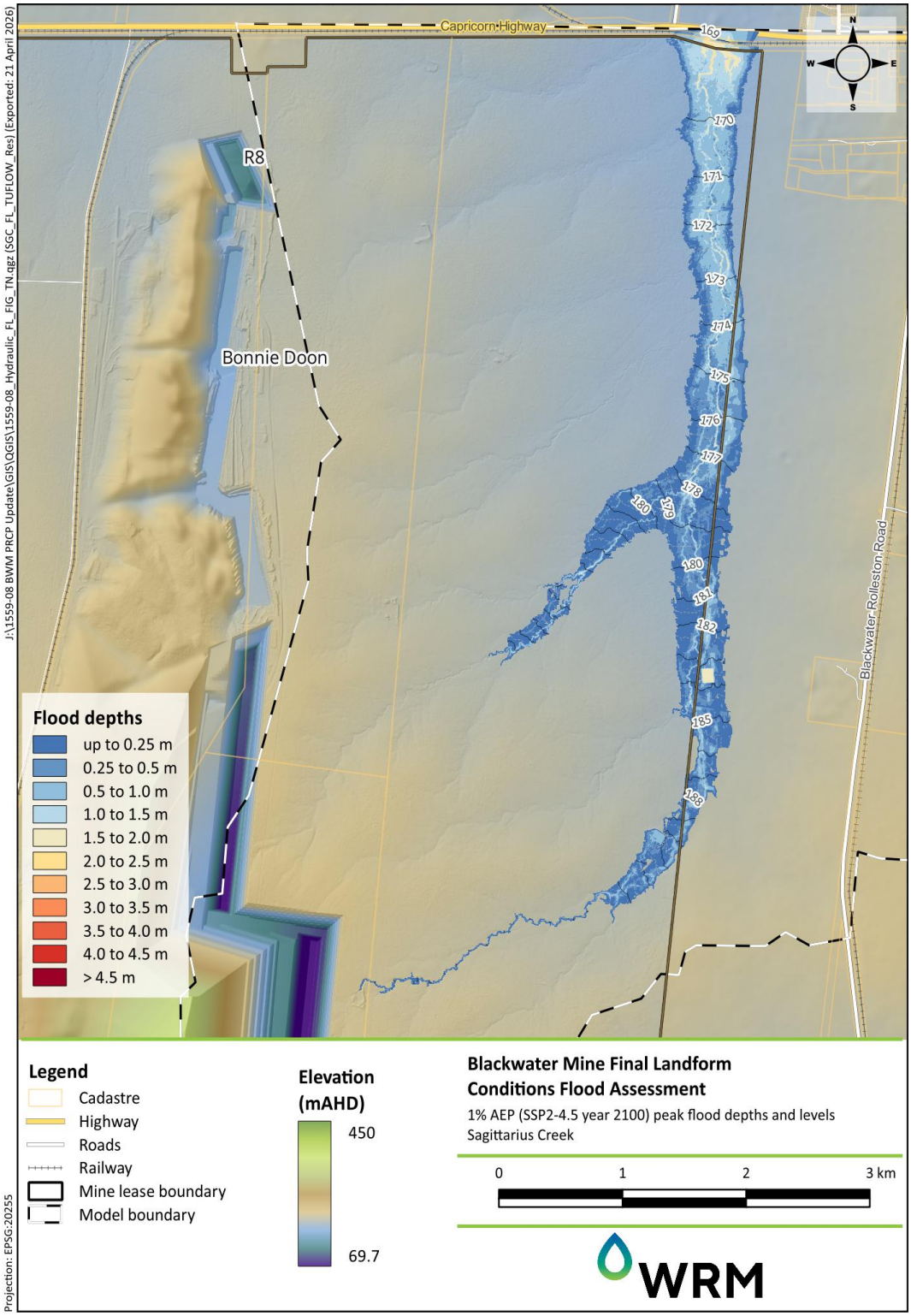


Figure C.5 Final landform conditions 1% AEP peak flood depths, levels and extents, Sagittarius Creek

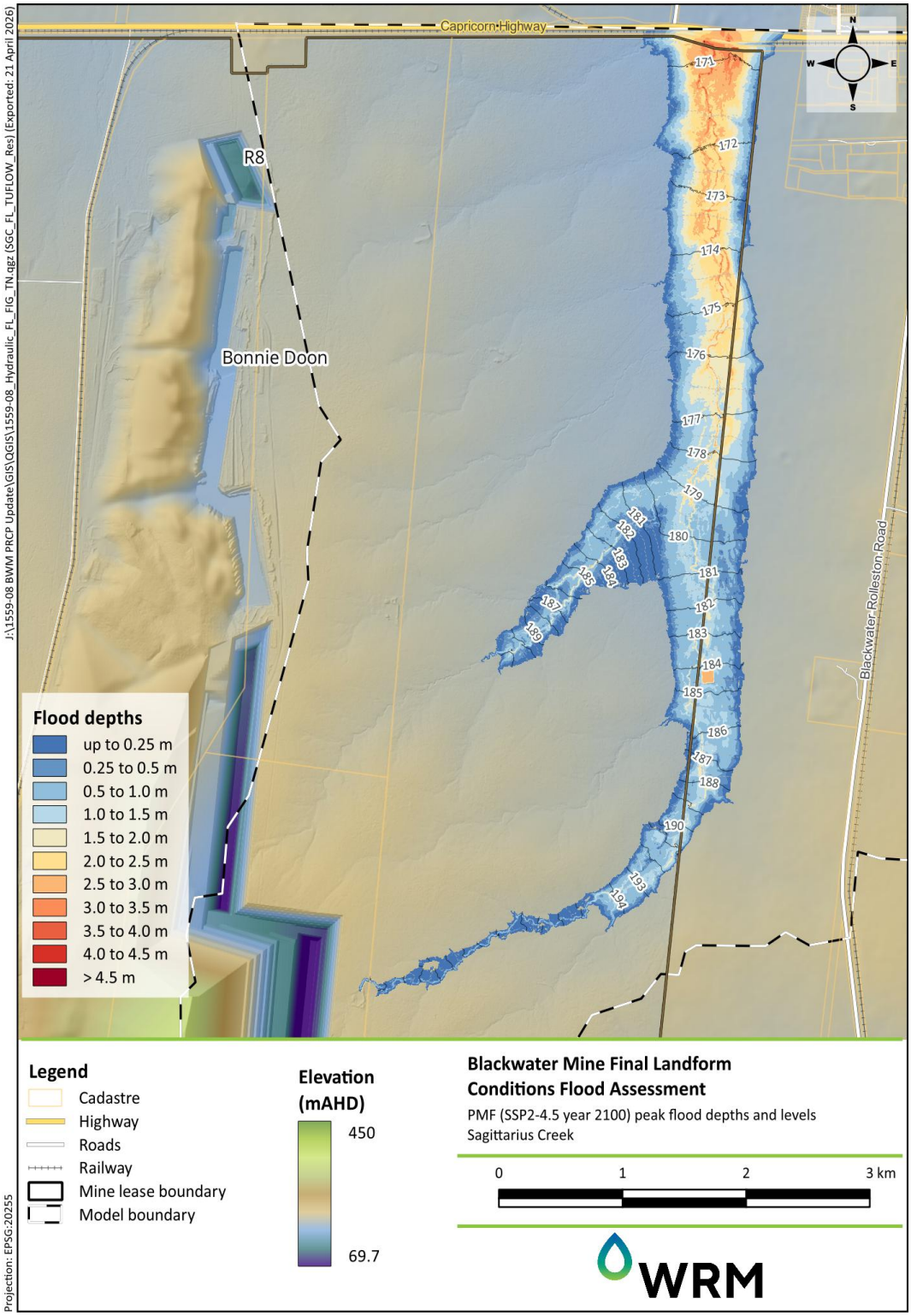


Figure C.6 Final landform conditions PMF peak flood depths, levels and extents, Sagittarius Creek

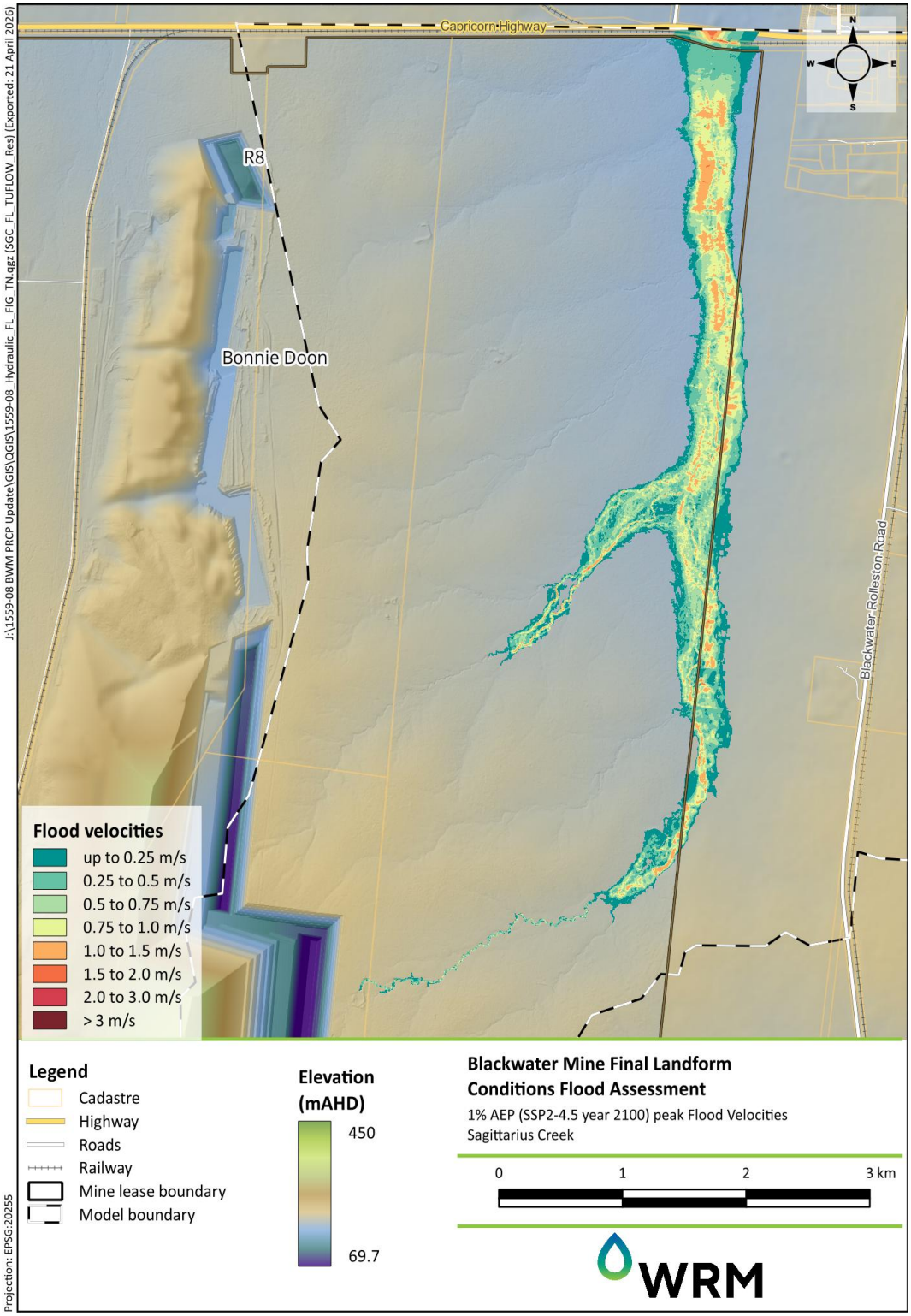


Figure C.7 Final landform conditions 1% AEP peak flood velocities, Sagittarius Creek

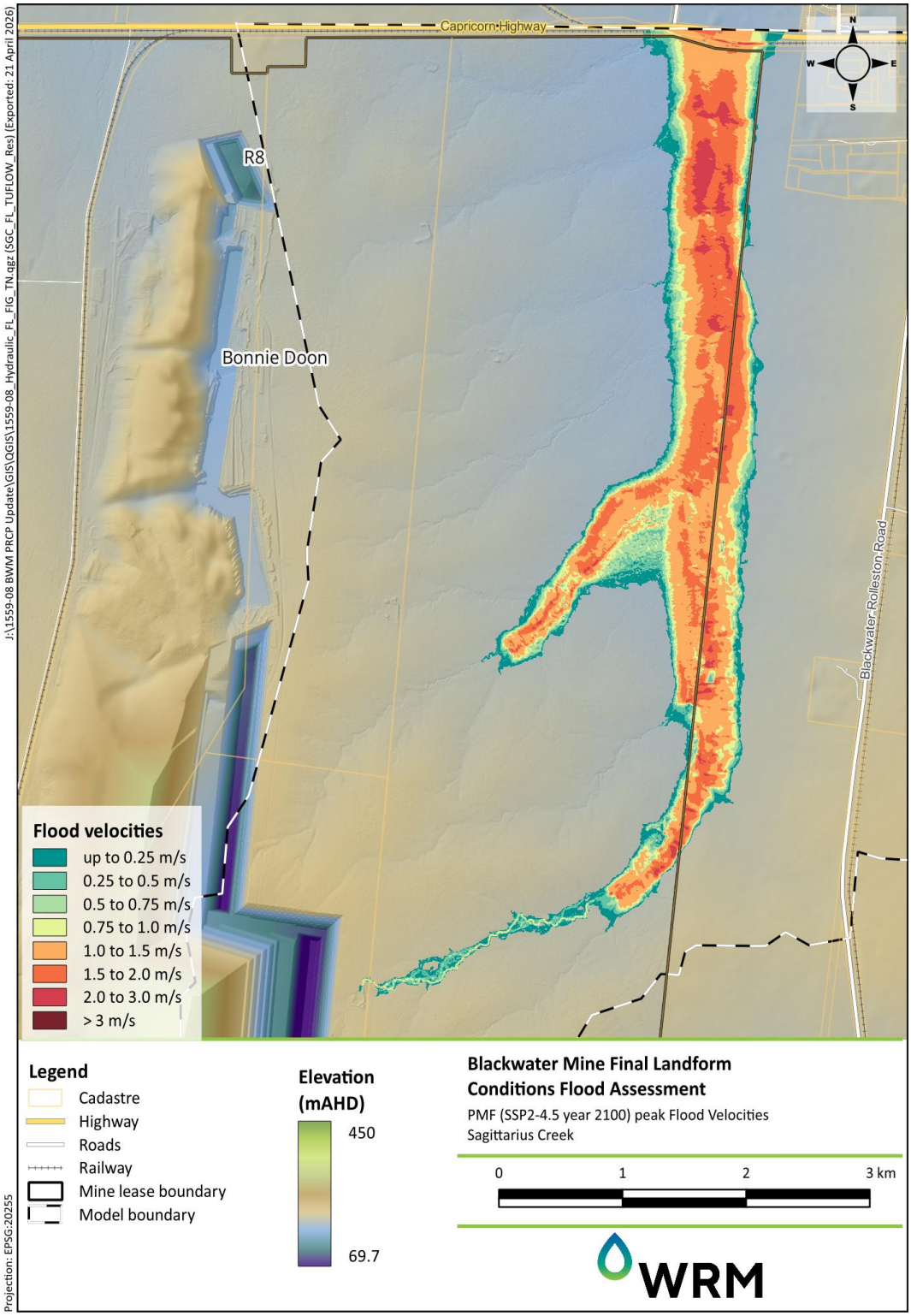


Figure C.8 Final landform conditions PMF peak flood velocities, Sagittarius Creek

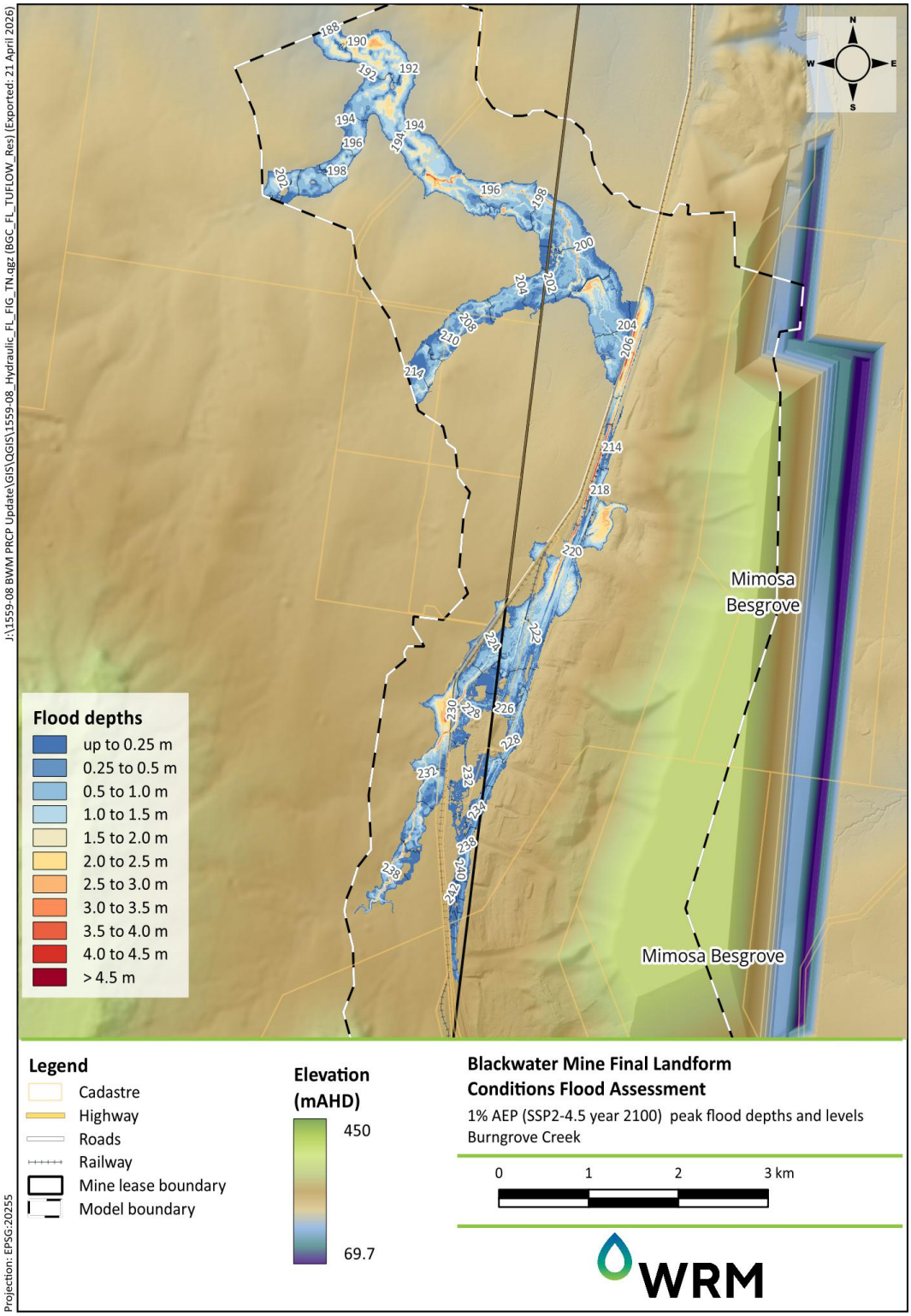


Figure C.9 Final landform conditions 1% AEP peak flood depths, levels and extents, Burngrove Creek

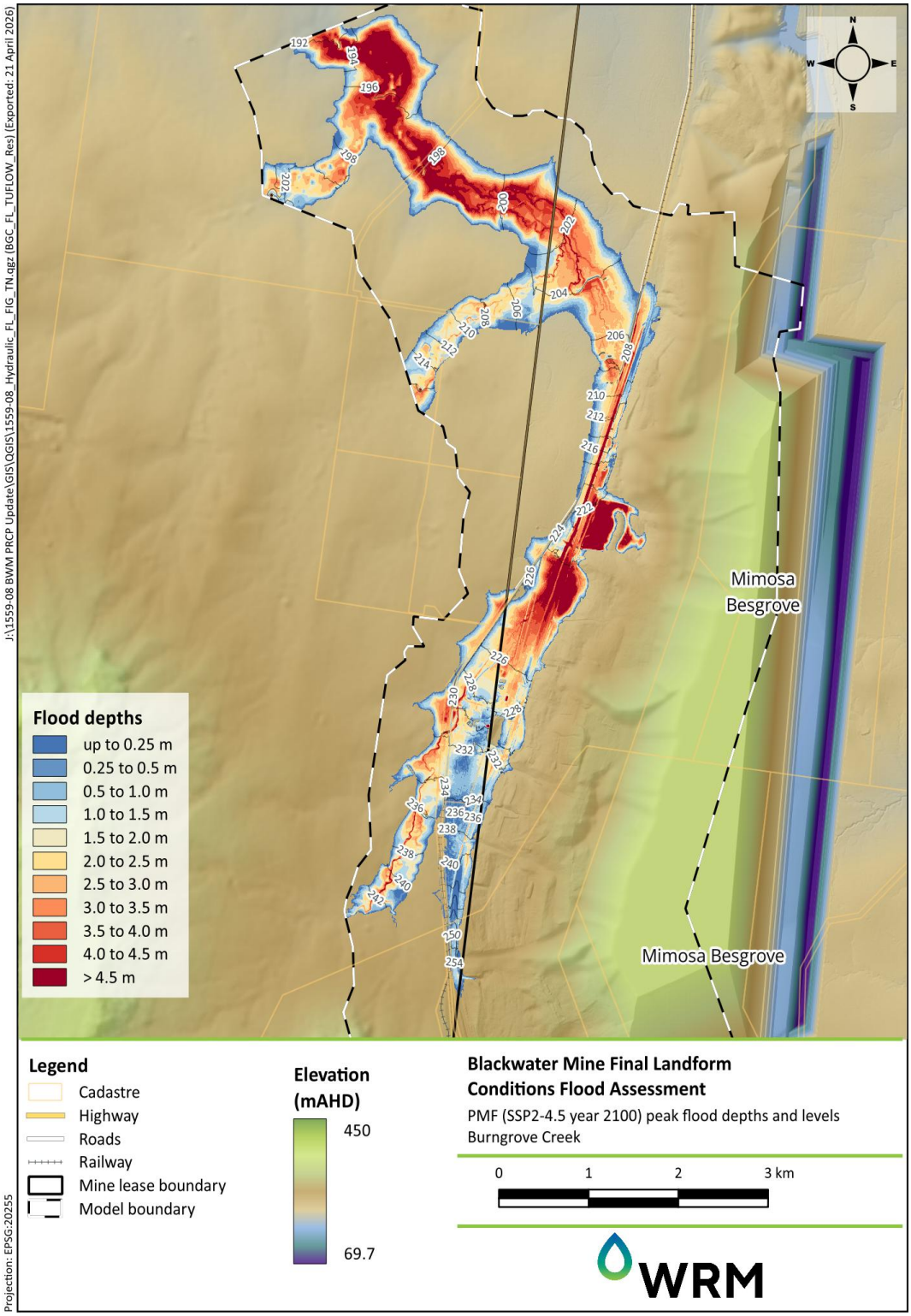


Figure C.10 Final landform conditions PMF peak flood depths, levels and extents, Burngrove Creek

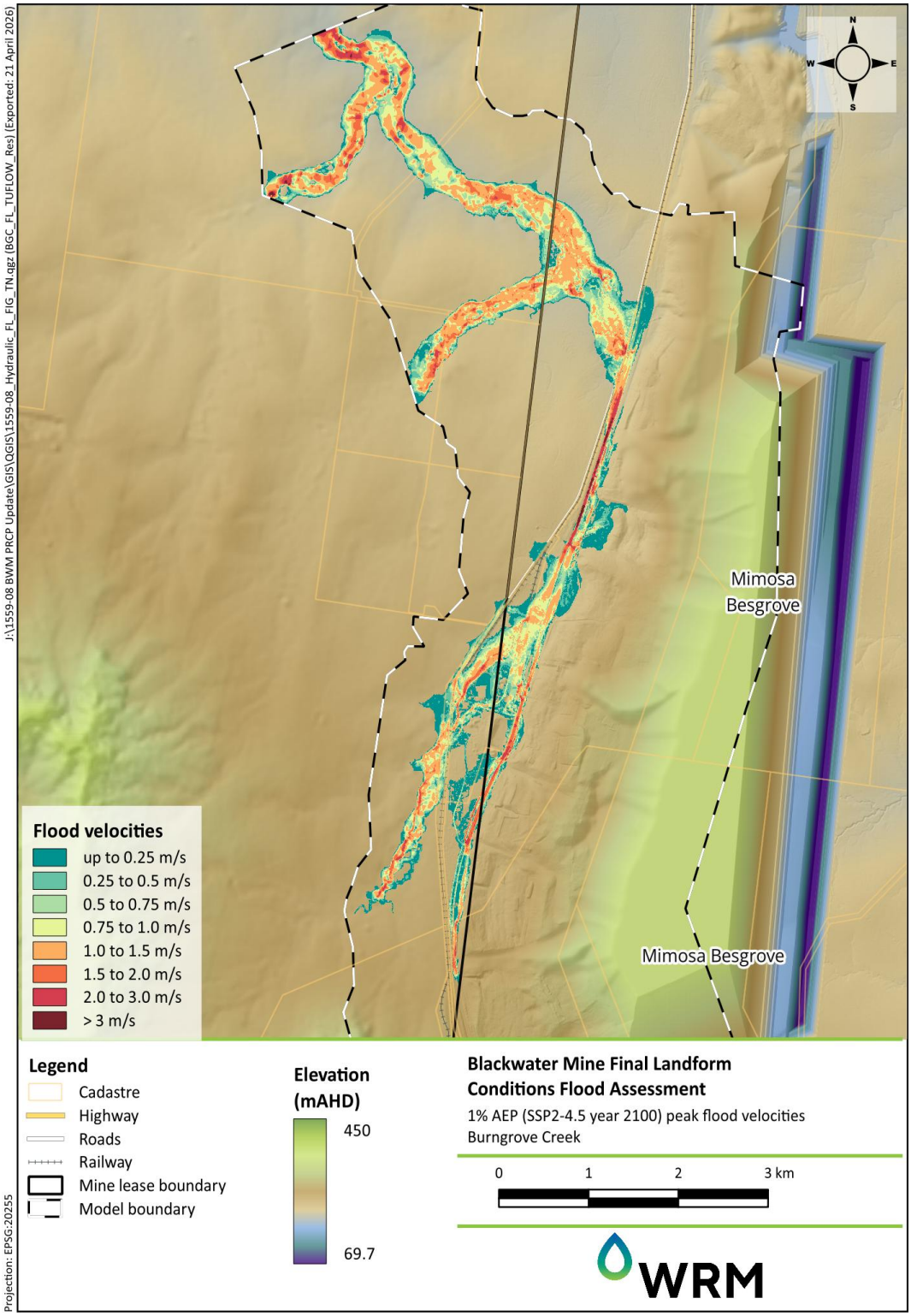


Figure C.11 **Final landform conditions 1% AEP peak flood velocities, Burngrove Creek**

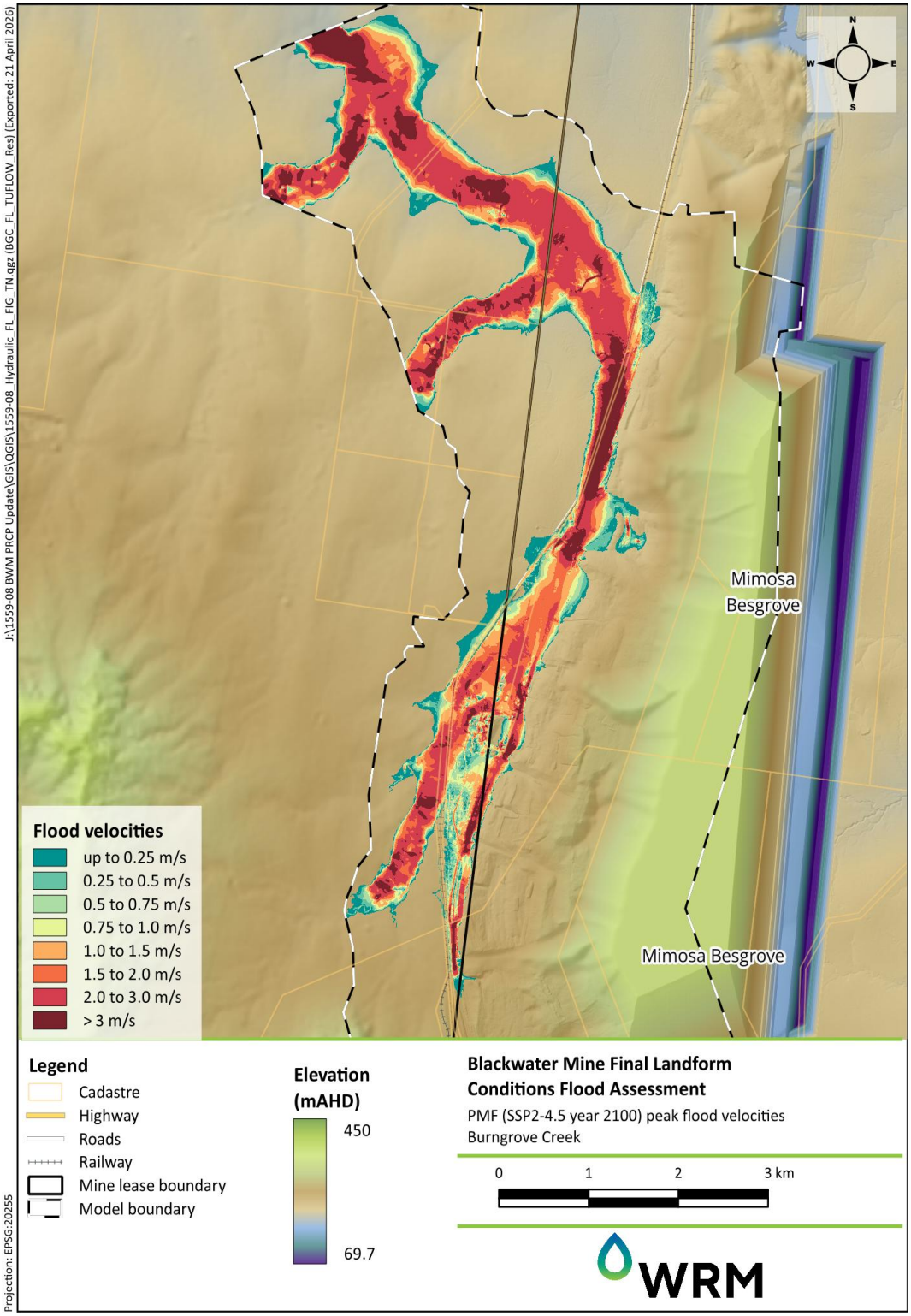


Figure C.12 **Final landform conditions PMF peak flood velocities, Burngrove Creek**

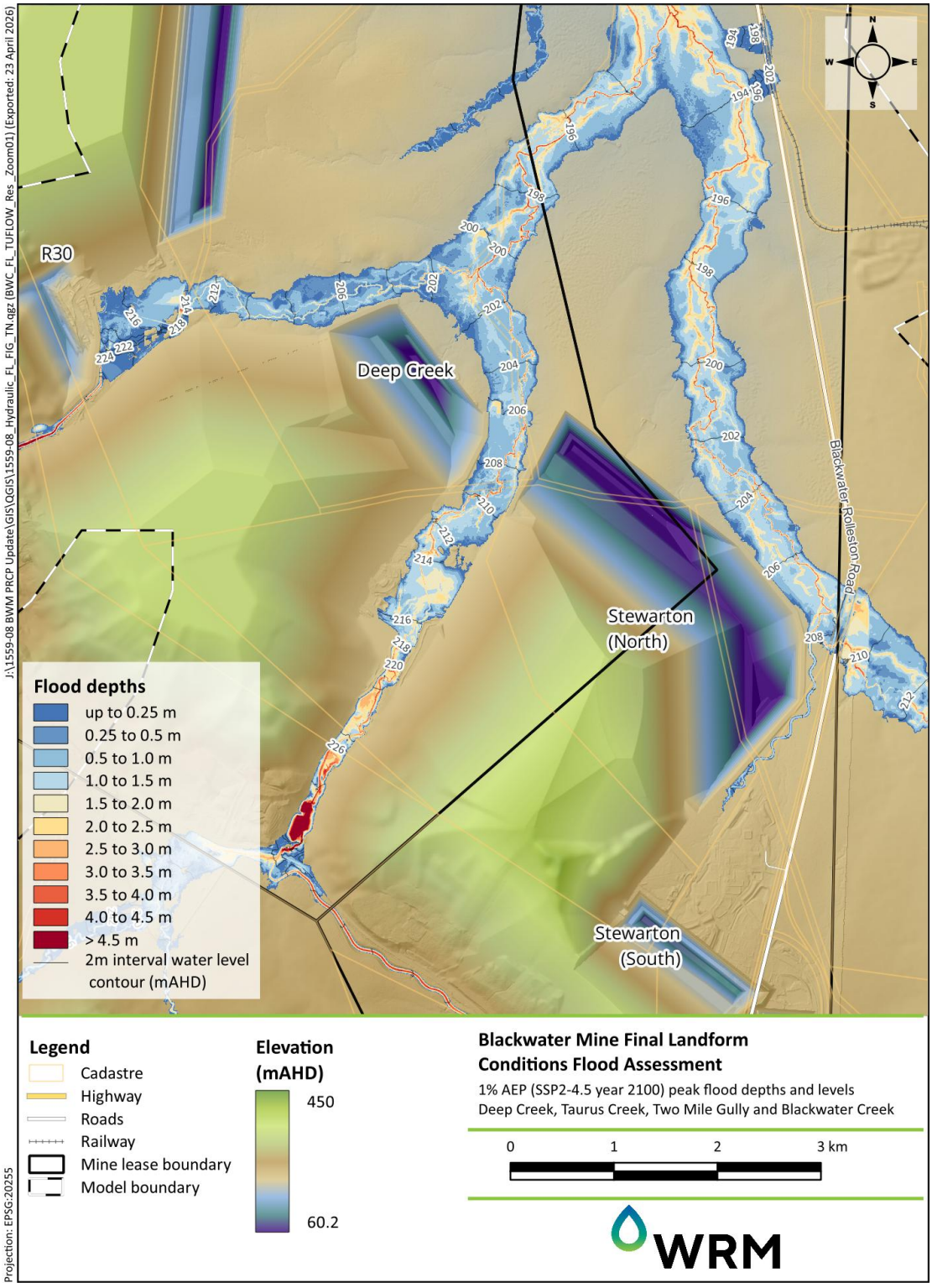


Figure C.13 Final landform conditions 1% AEP peak flood depths, levels and extents, Deep Creek, Taurus Creek and Two Mile Gully (adjacent to the Stewarton North Void)

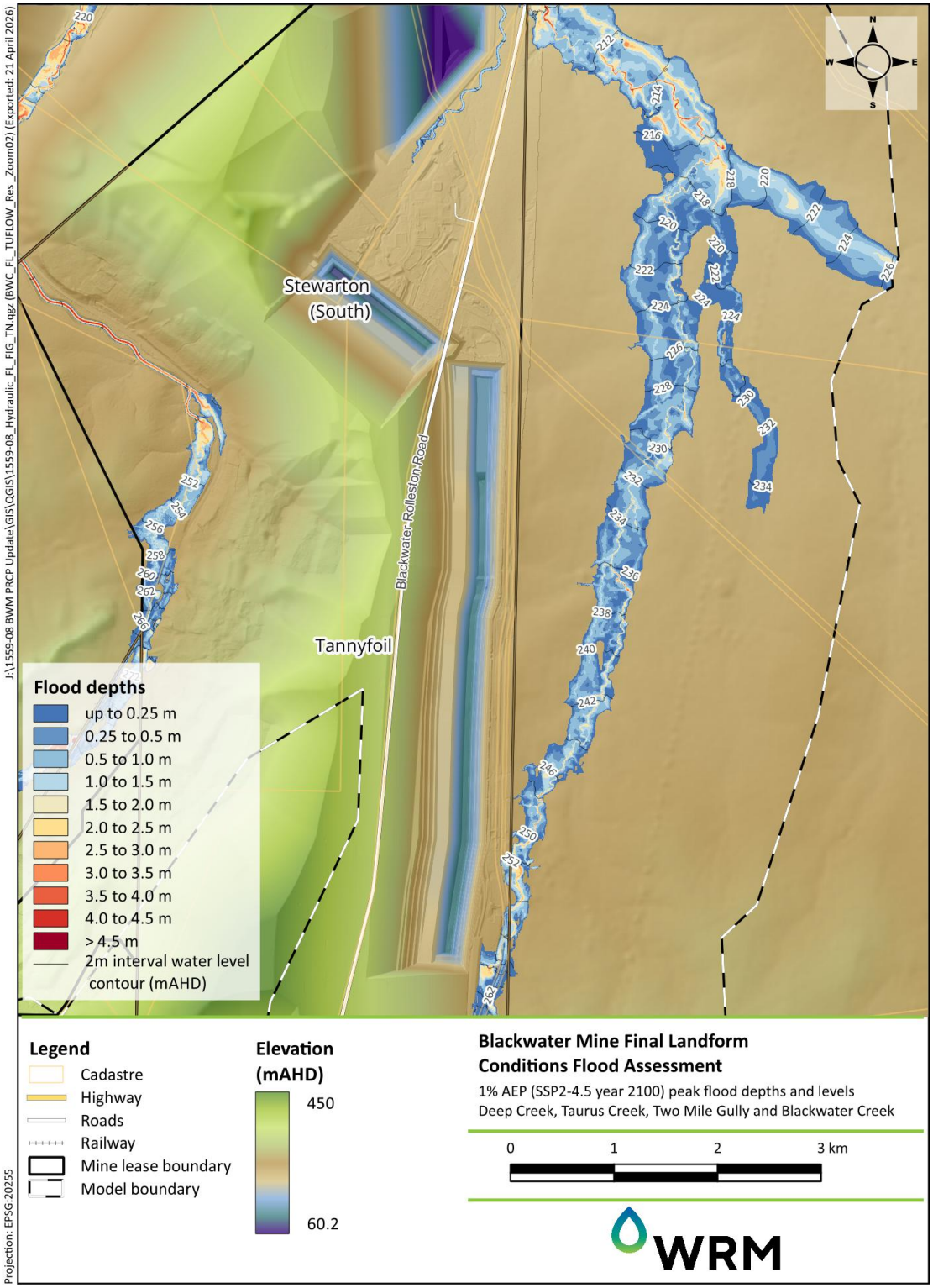


Figure C.14 Final landform conditions 1% AEP peak flood depths, levels and extents, Two Mile Gully (adjacent to the Tannyfoil Void)

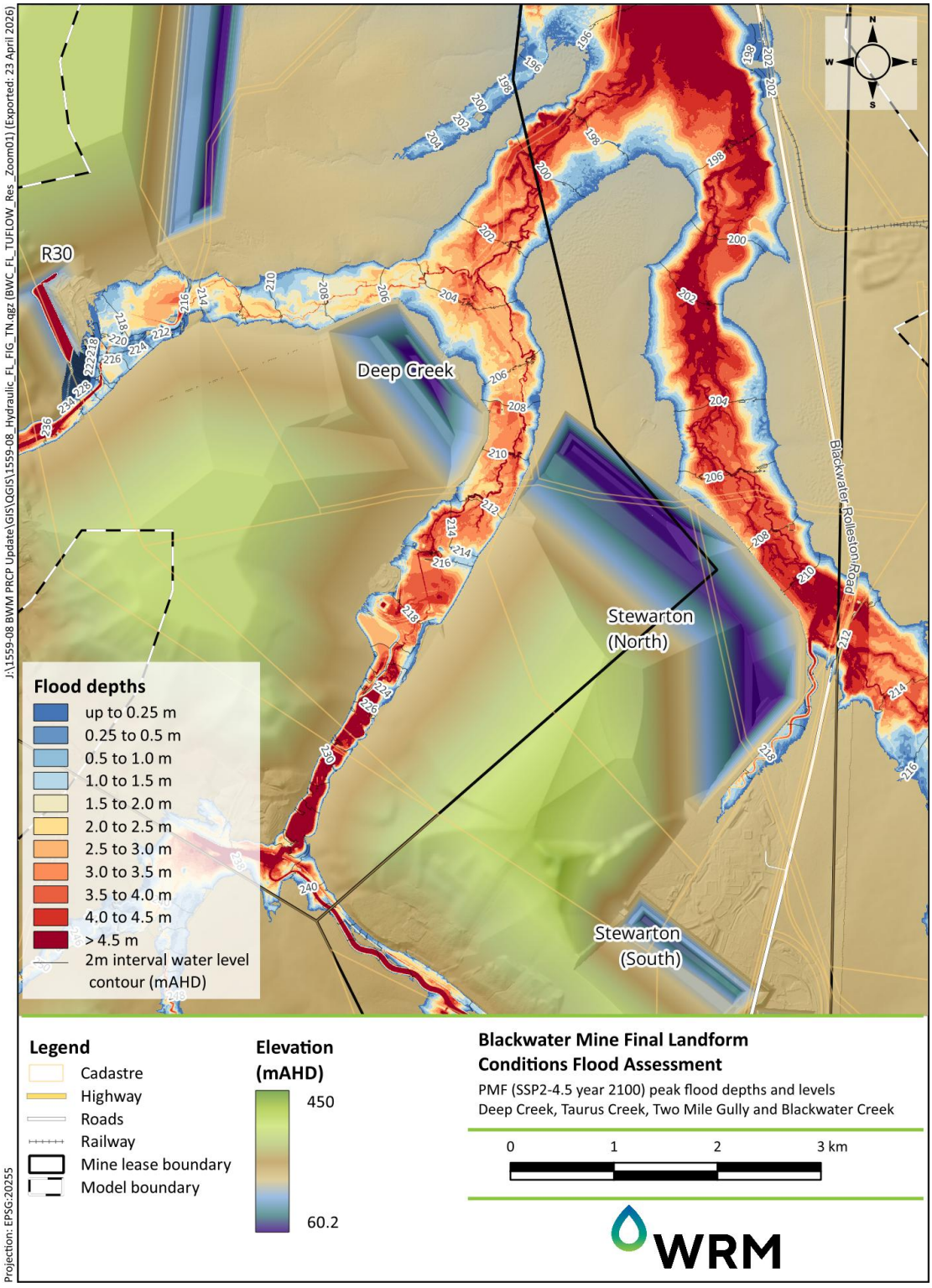


Figure C.15 Final landform conditions PMF peak flood depths, levels and extents, Deep Creek, Taurus Creek and Two Mile Gully (adjacent to the Stewarton North Void)

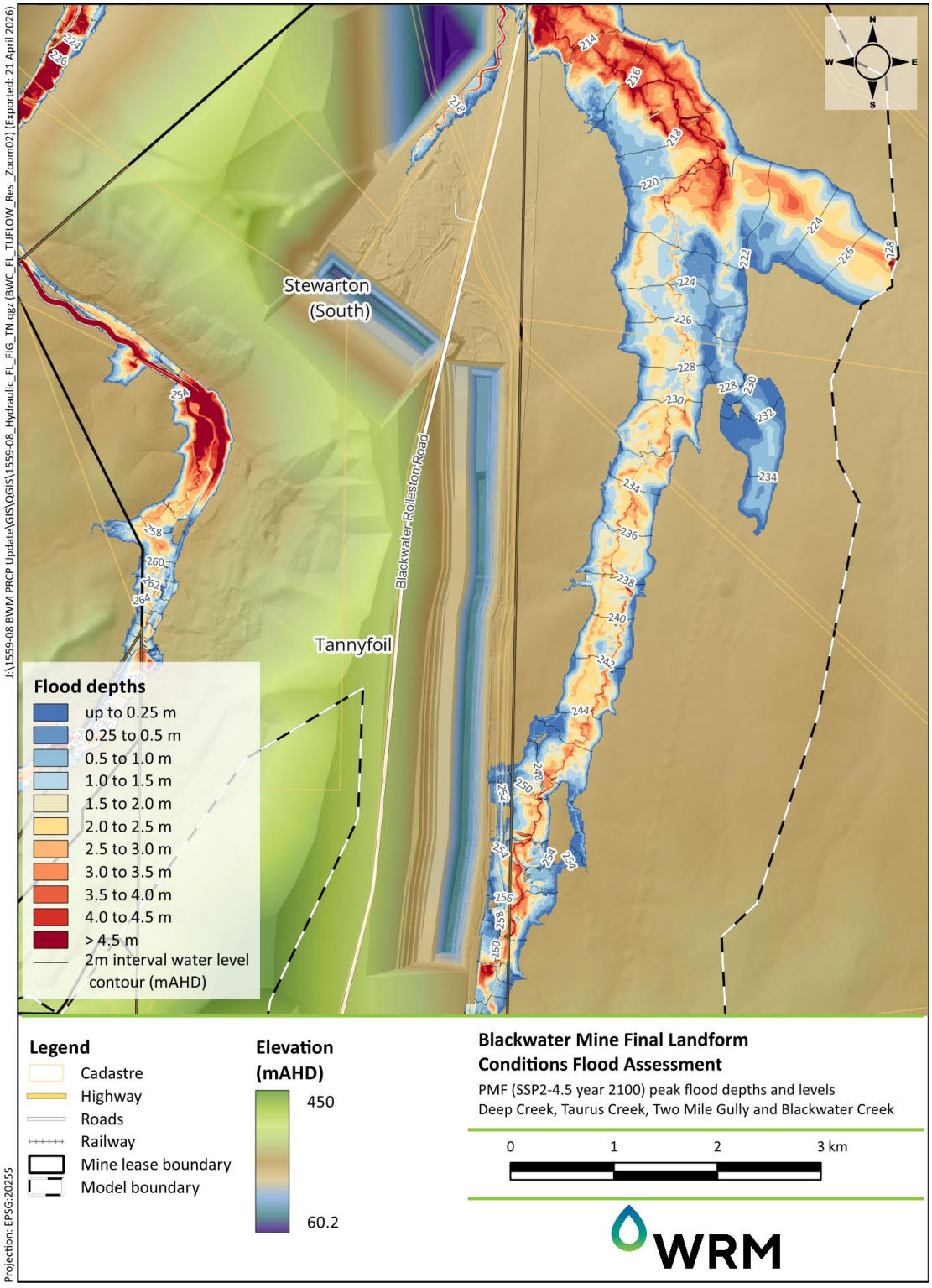


Figure C.16 Final landform conditions PMF peak flood depths, levels and extents, Two Mile Gully (adjacent to the Tannyfoil Void)

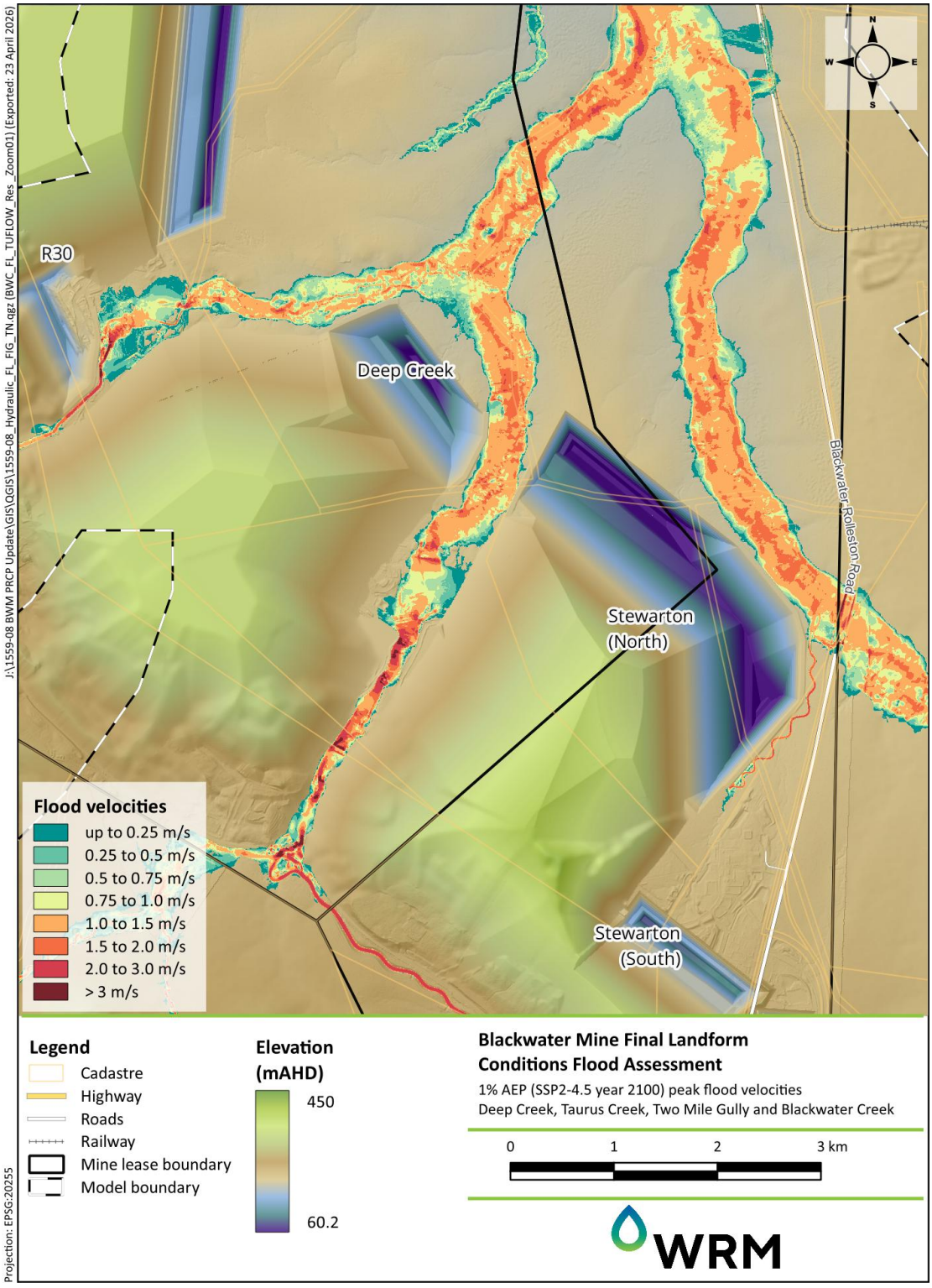


Figure C.17 Final landform conditions 1% AEP peak flood velocities, Deep Creek, Taurus Creek and Two Mile Gully (adjacent to the Stewarton North Void)

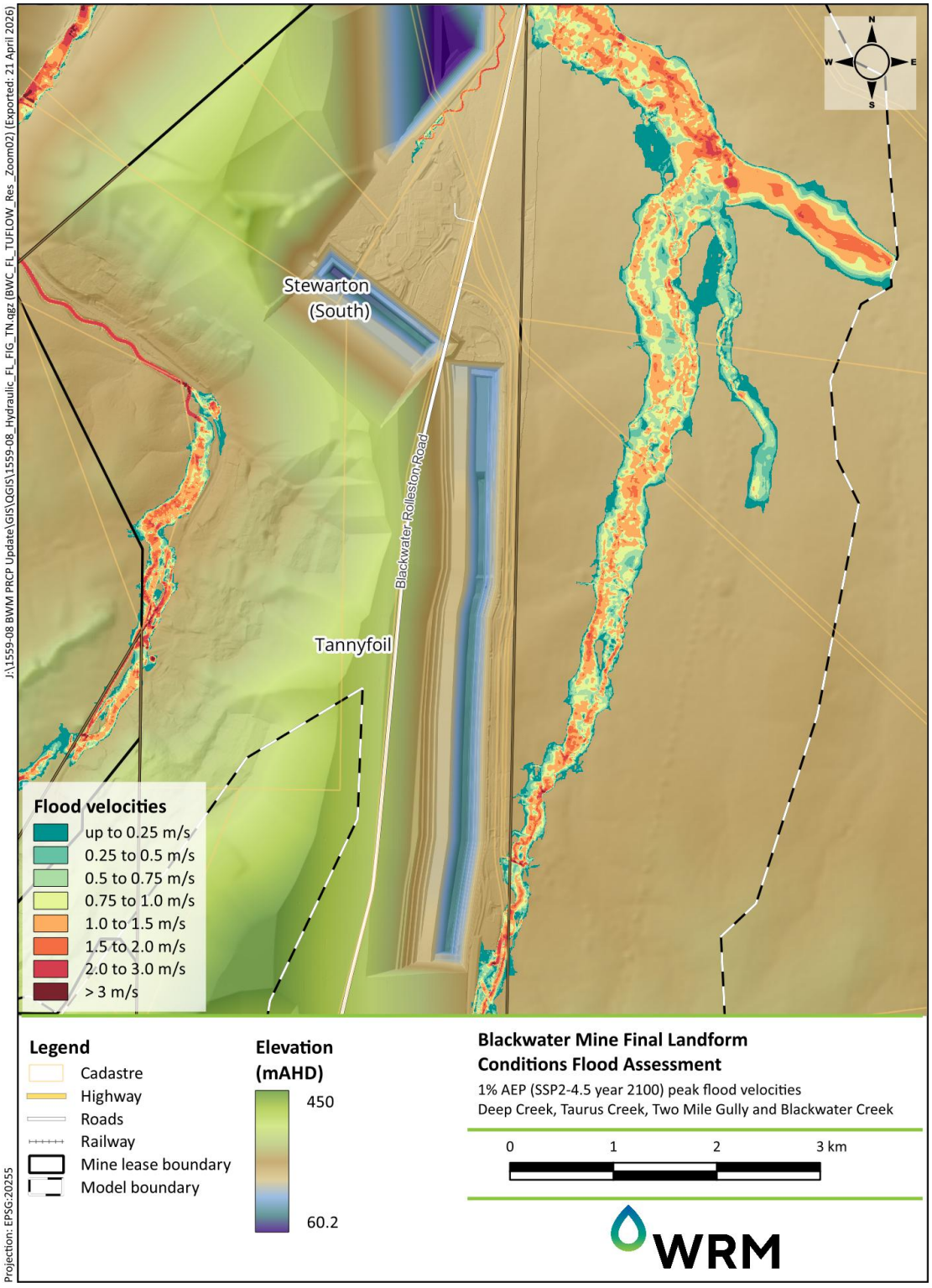


Figure C.18 Final landform conditions 1% AEP peak flood velocities, Two Mile Gully (adjacent to the Tannyfoil Void)

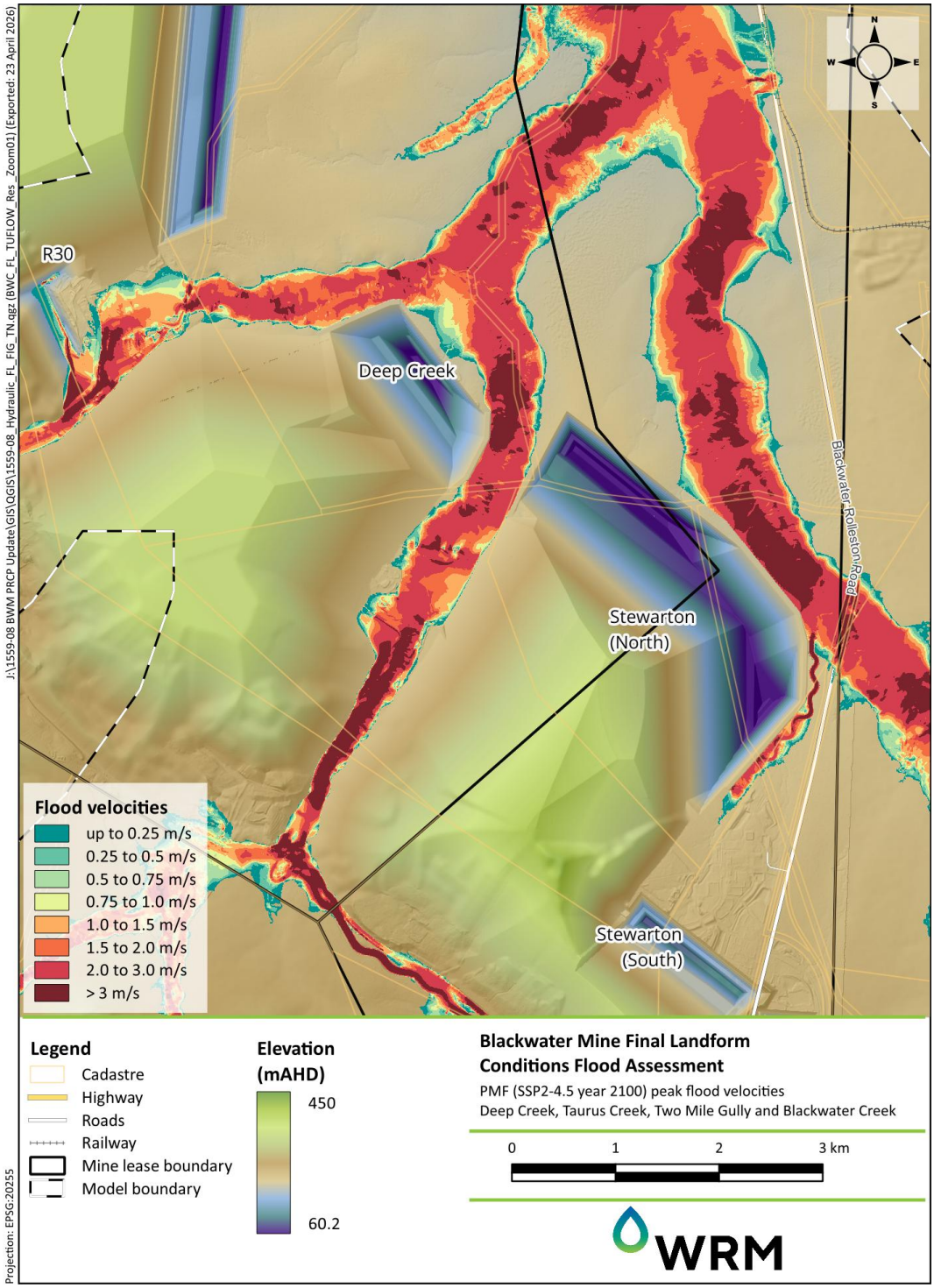


Figure C.19 Final landform conditions PMF peak flood velocities, Deep Creek, Taurus Creek and Two Mile Gully (adjacent to the Stewarton North Void)

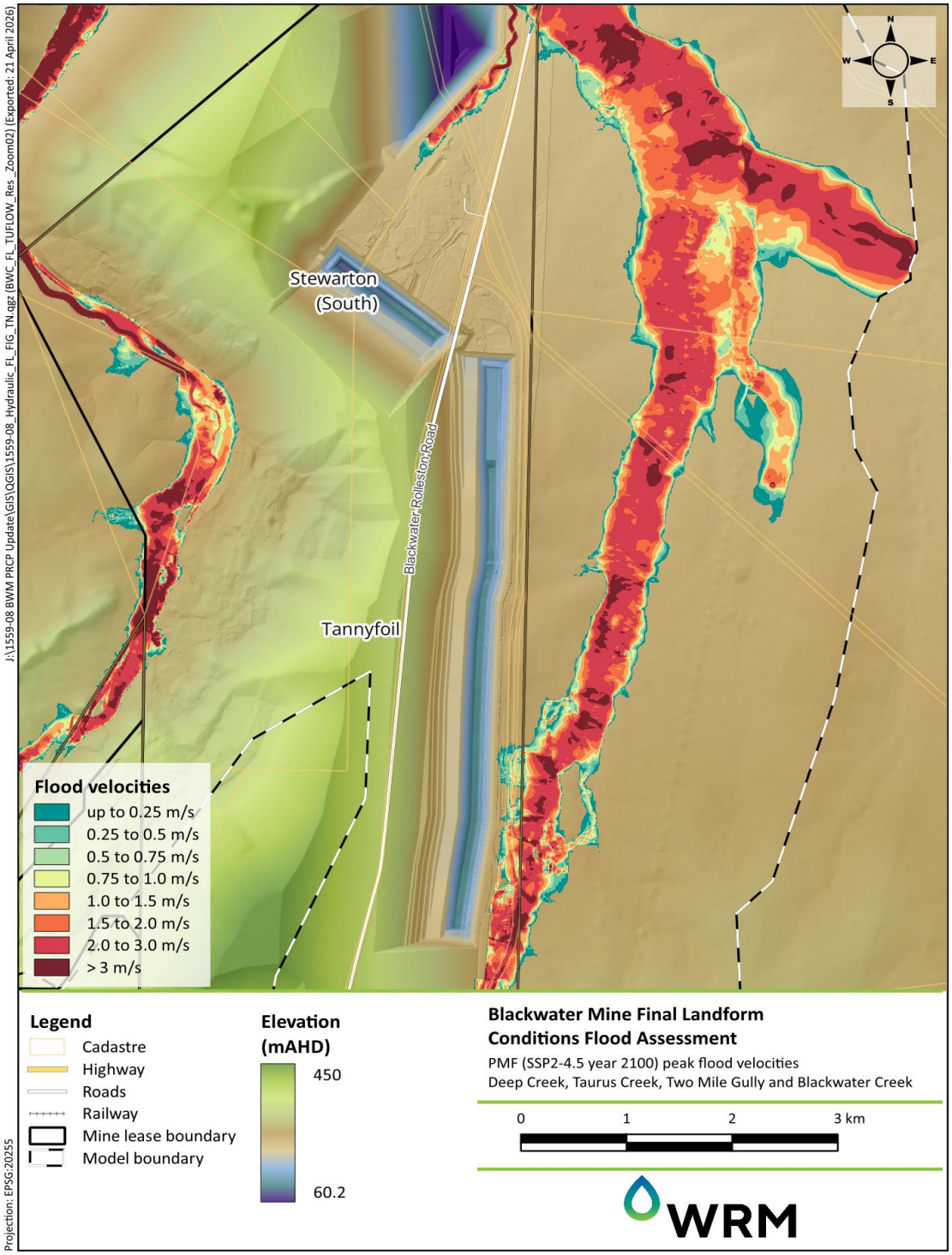


Figure C.20 Final landform conditions PMF peak flood velocities, Two Mile Gully (adjacent to the Tannyfoil Void)

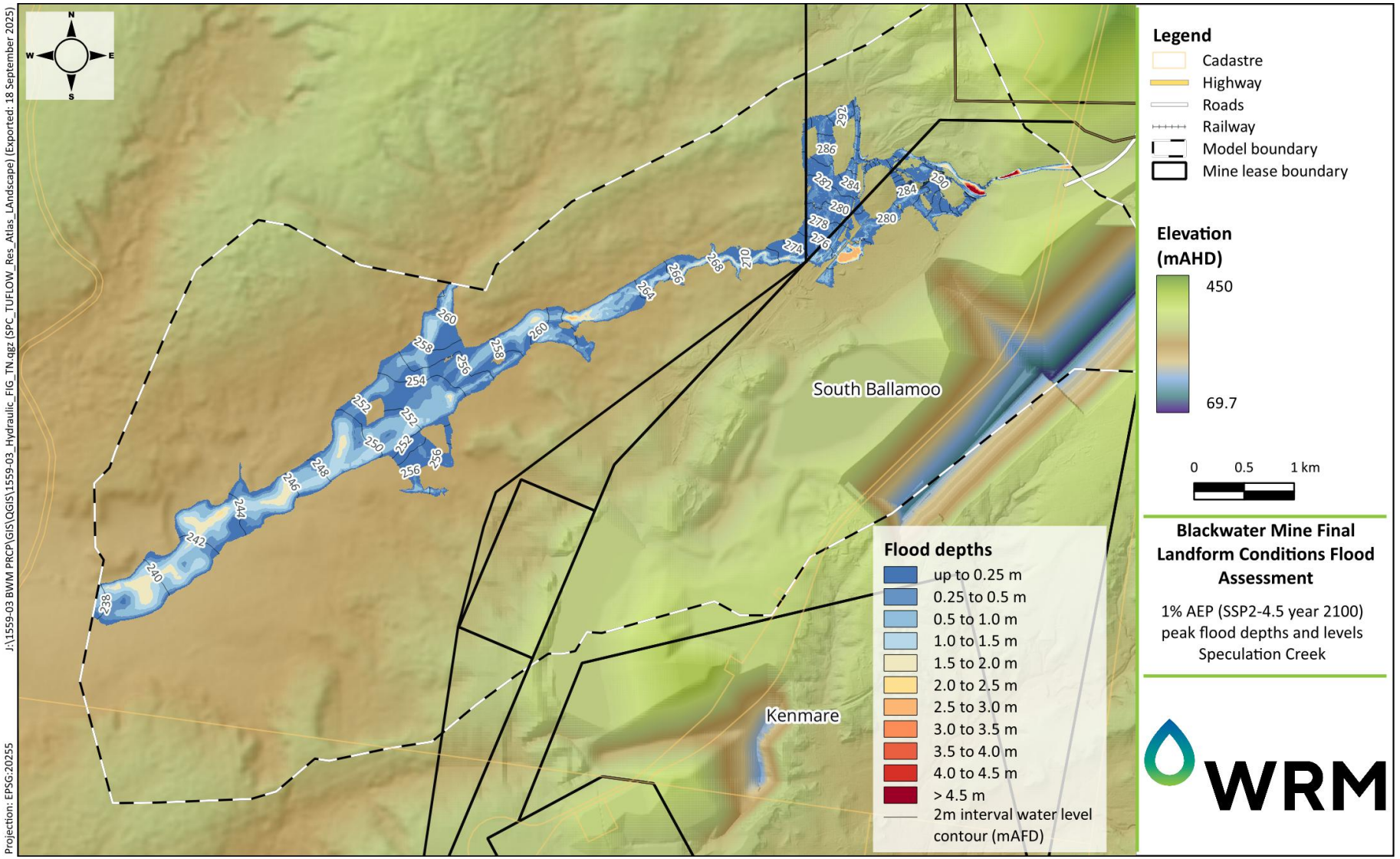


Figure C.21 **Final landform conditions 1% AEP peak flood depths, levels and extents, Speculation Creek**

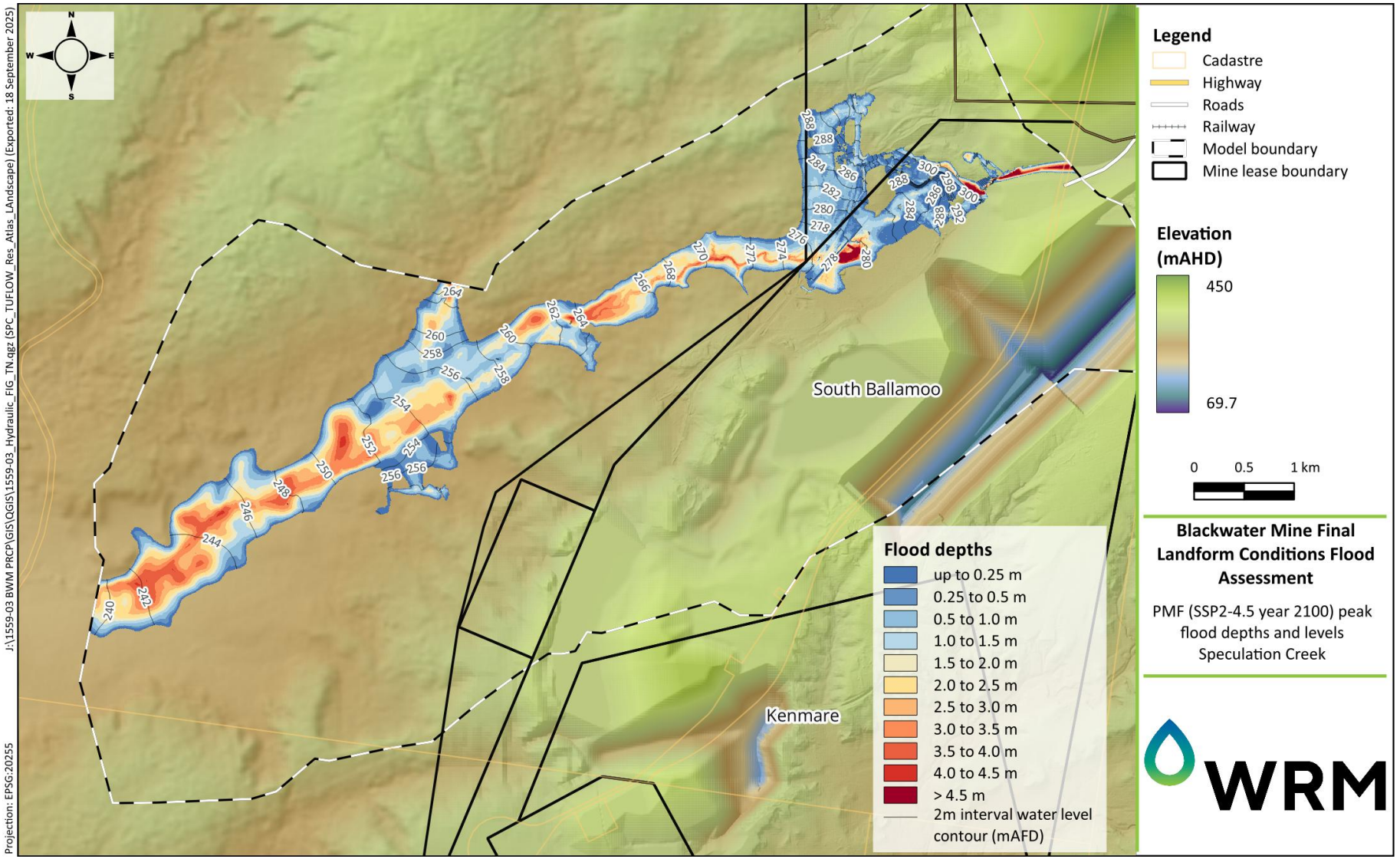


Figure C.22 **Final landform conditions PMF peak flood depths, levels and extents, Speculation Creek**

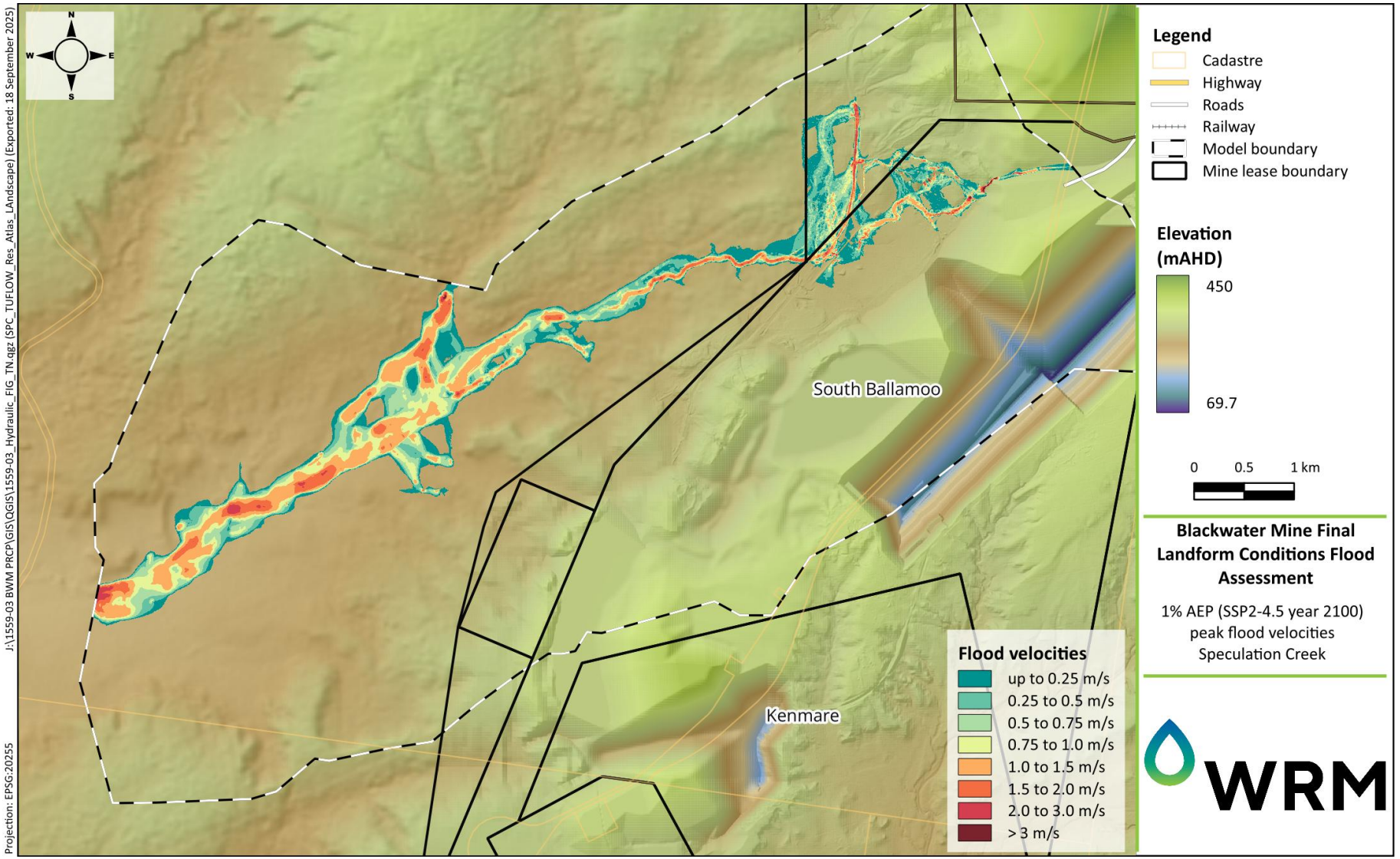


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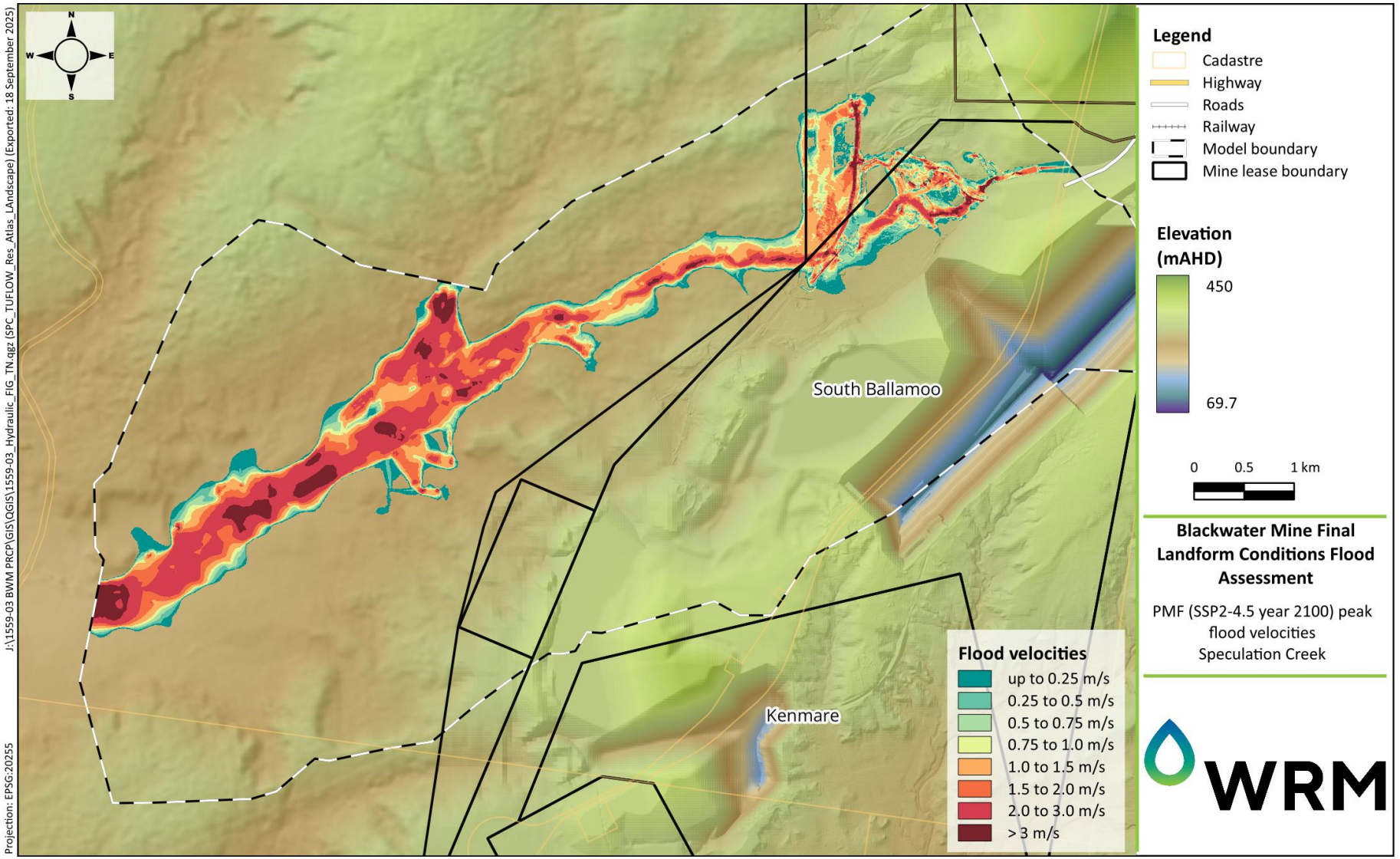


Figure C.24 **Final landform conditions PMF peak flood velocities, Speculation Creek**

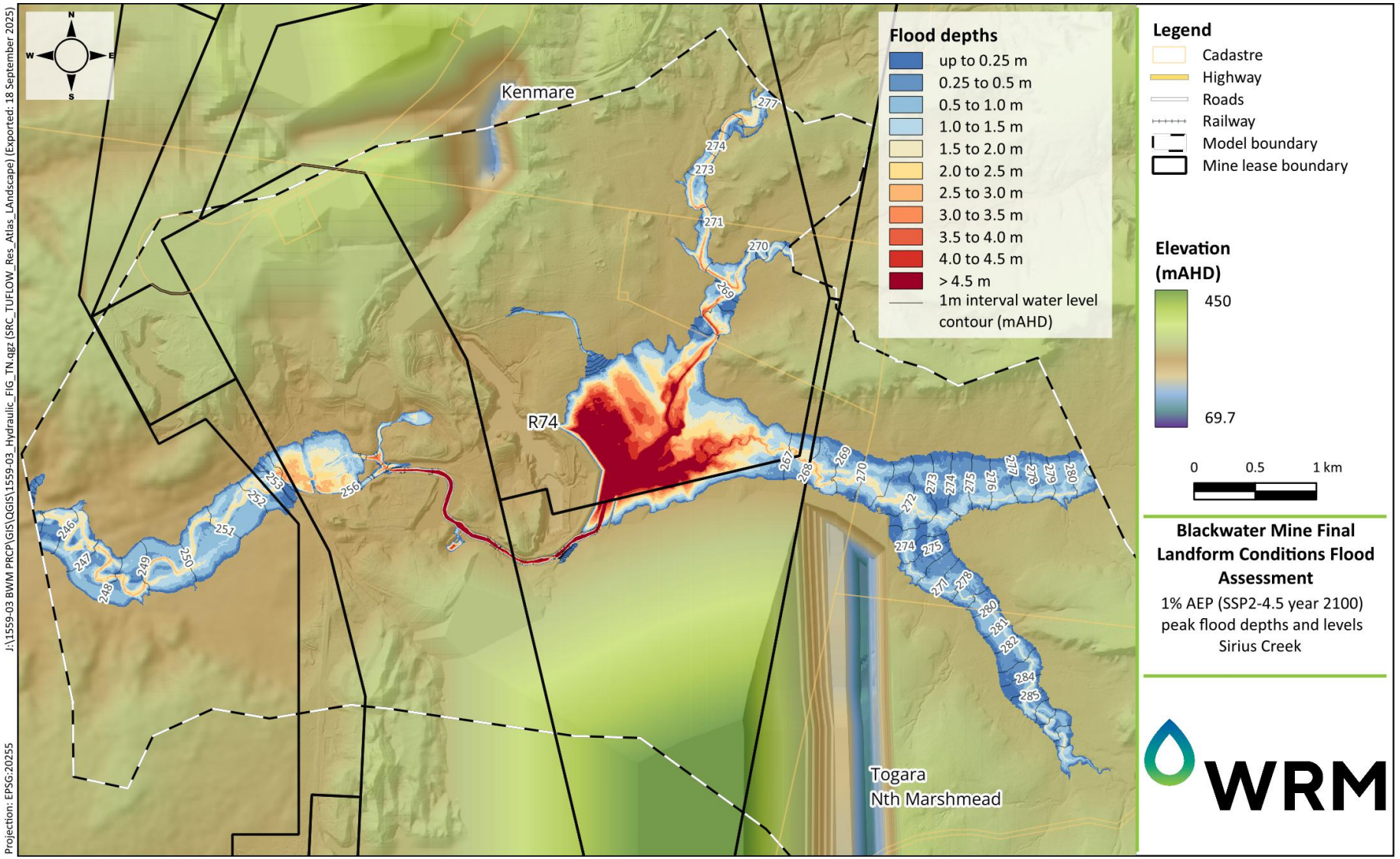


Figure C.25 **Final landform conditions 1% AEP peak flood depths, levels and extents, Sirius Creek**

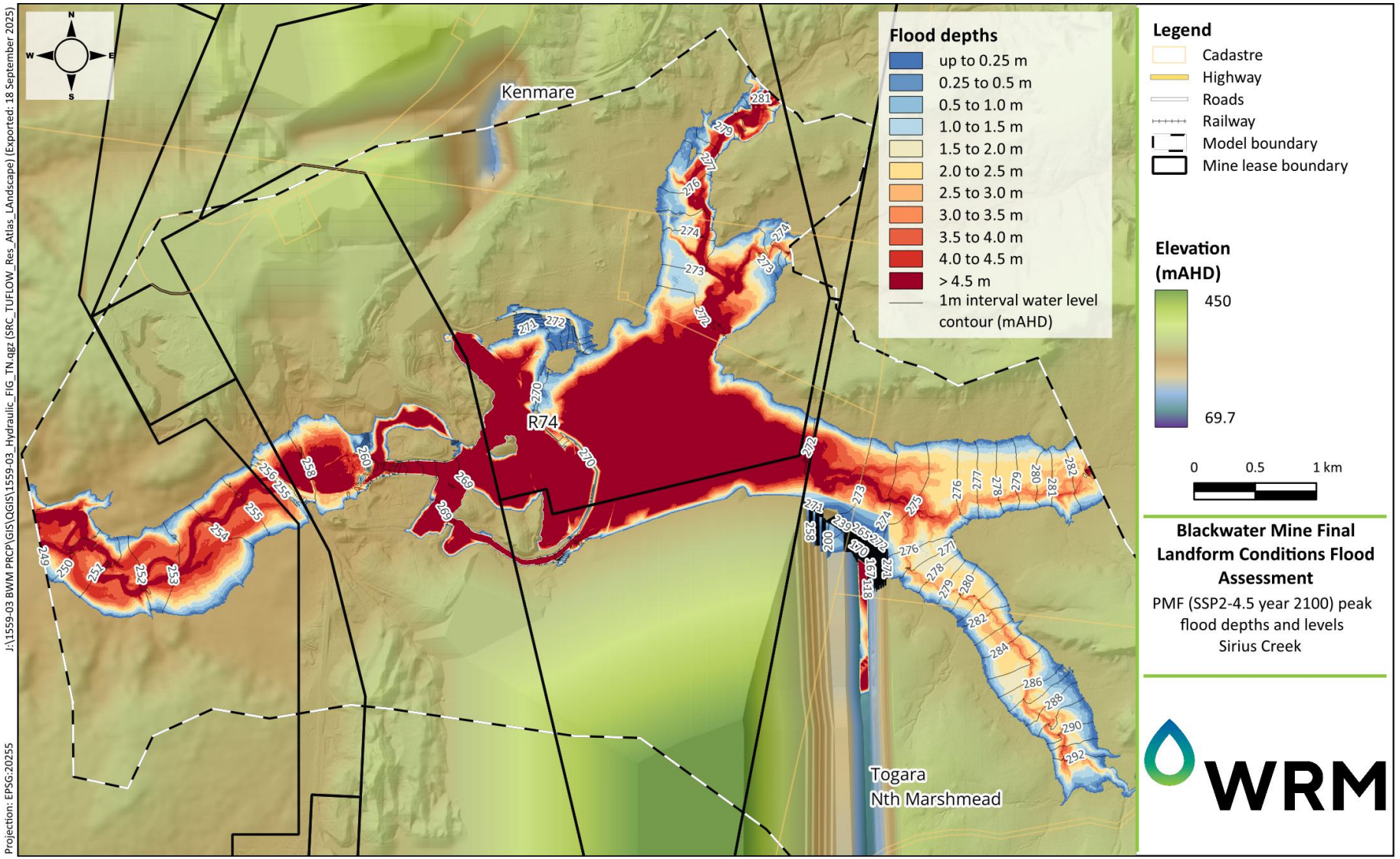


Figure C.26 **Final landform conditions PMF peak flood depths, levels and extents, Sirius Creek**

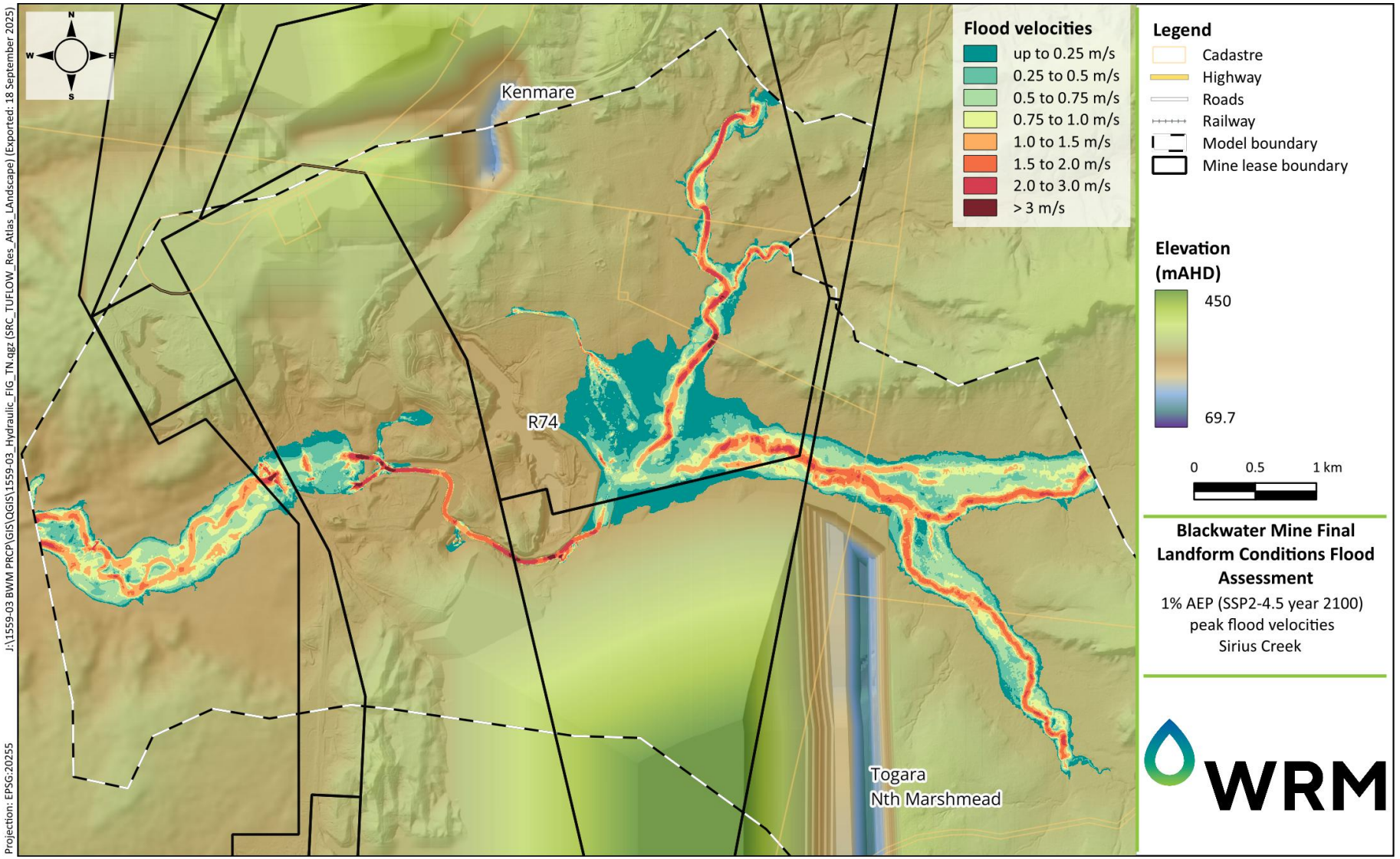


Figure C.27 **Final landform conditions 1% AEP peak flood velocities, Sirius Creek**

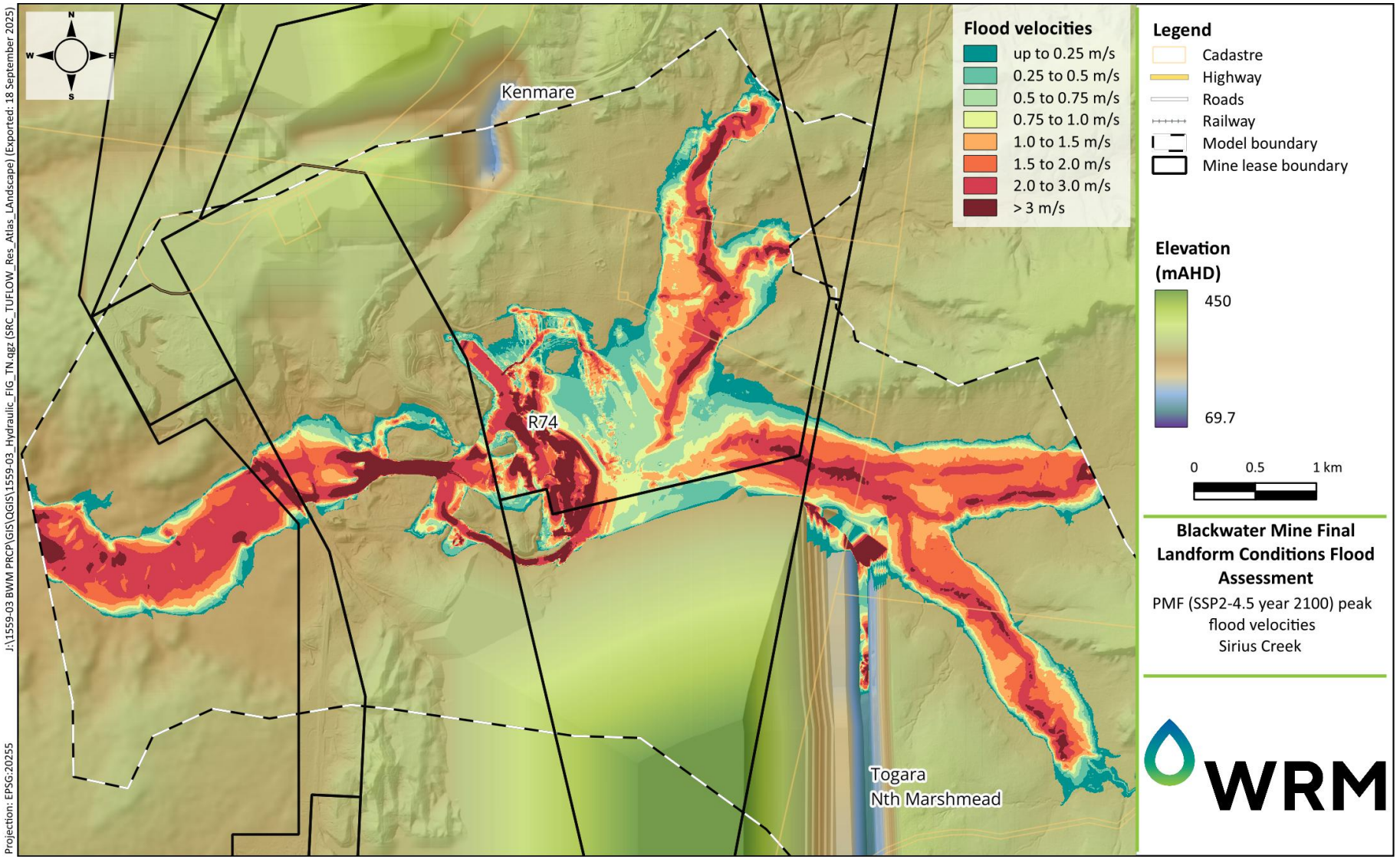


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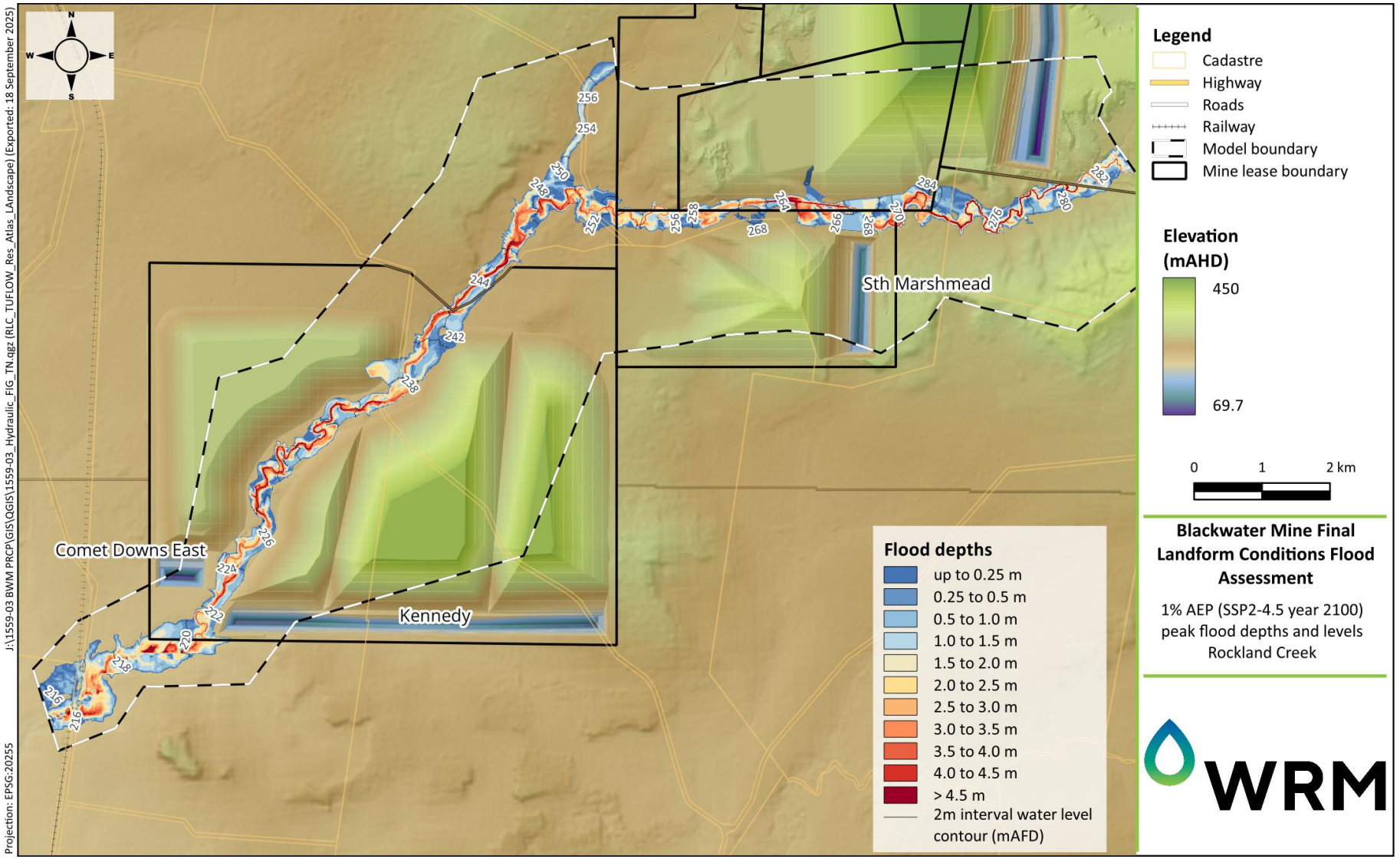


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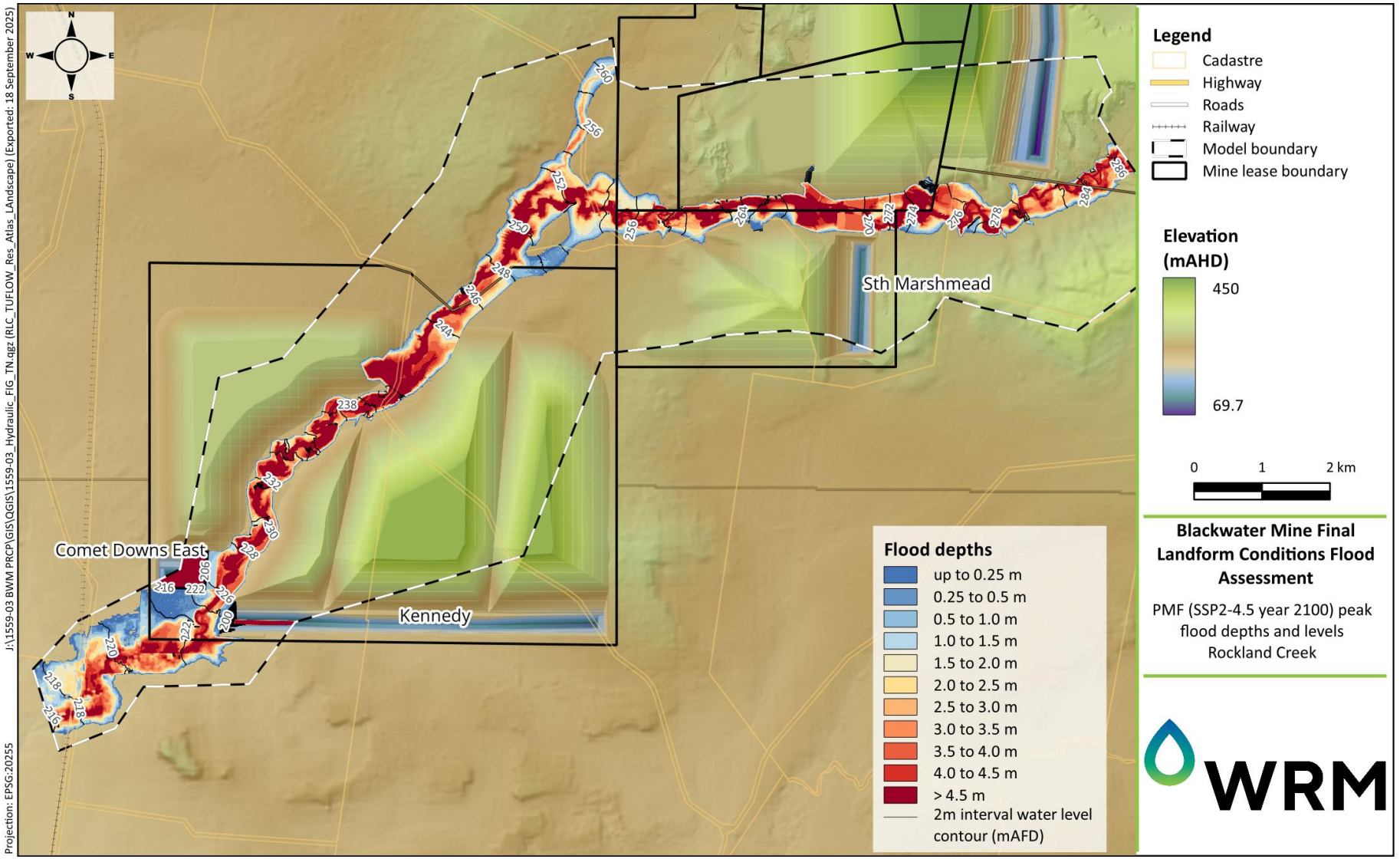


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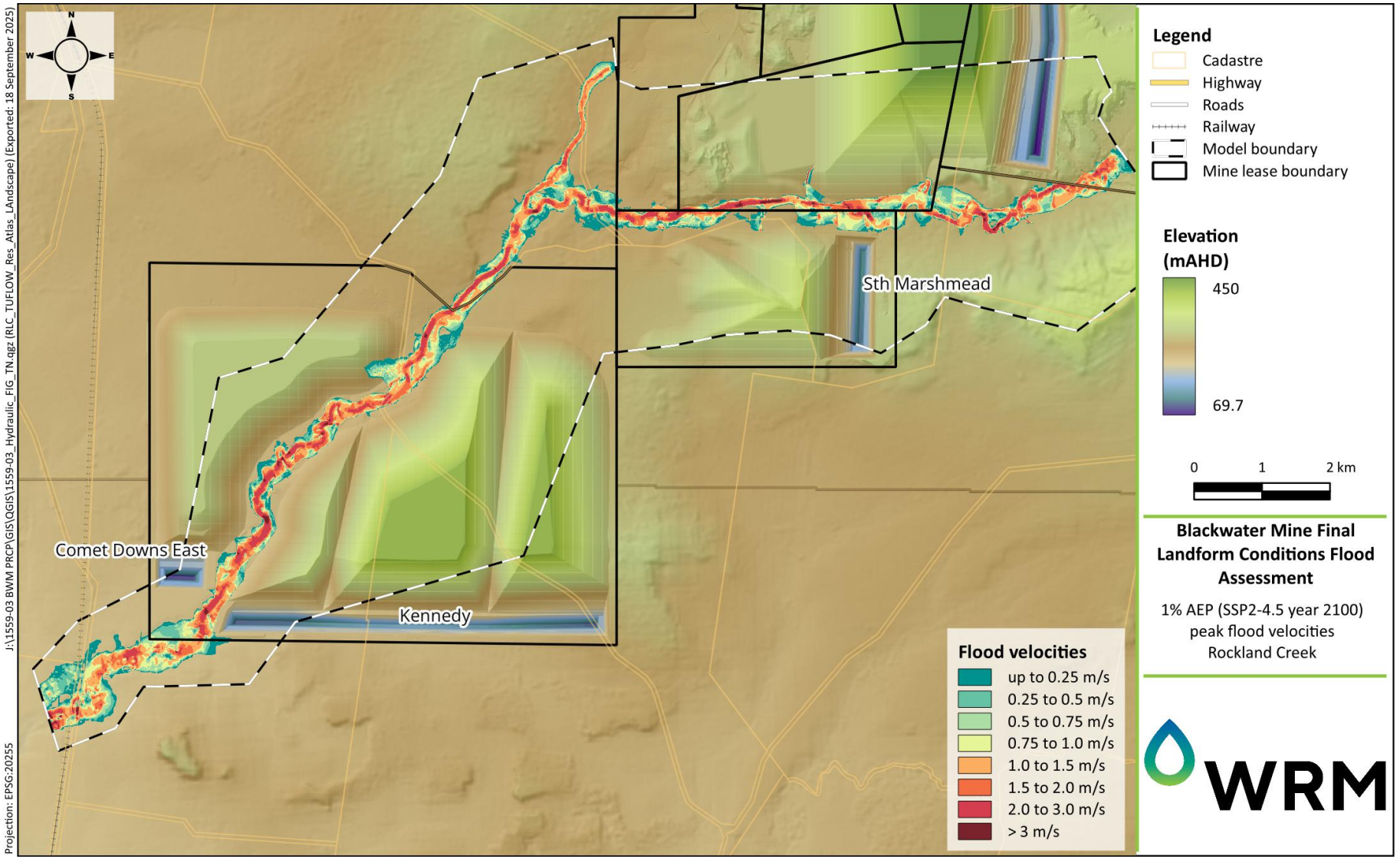


Figure C.31 **Final landform conditions 1% AEP peak flood velocities, Rockland Creek**

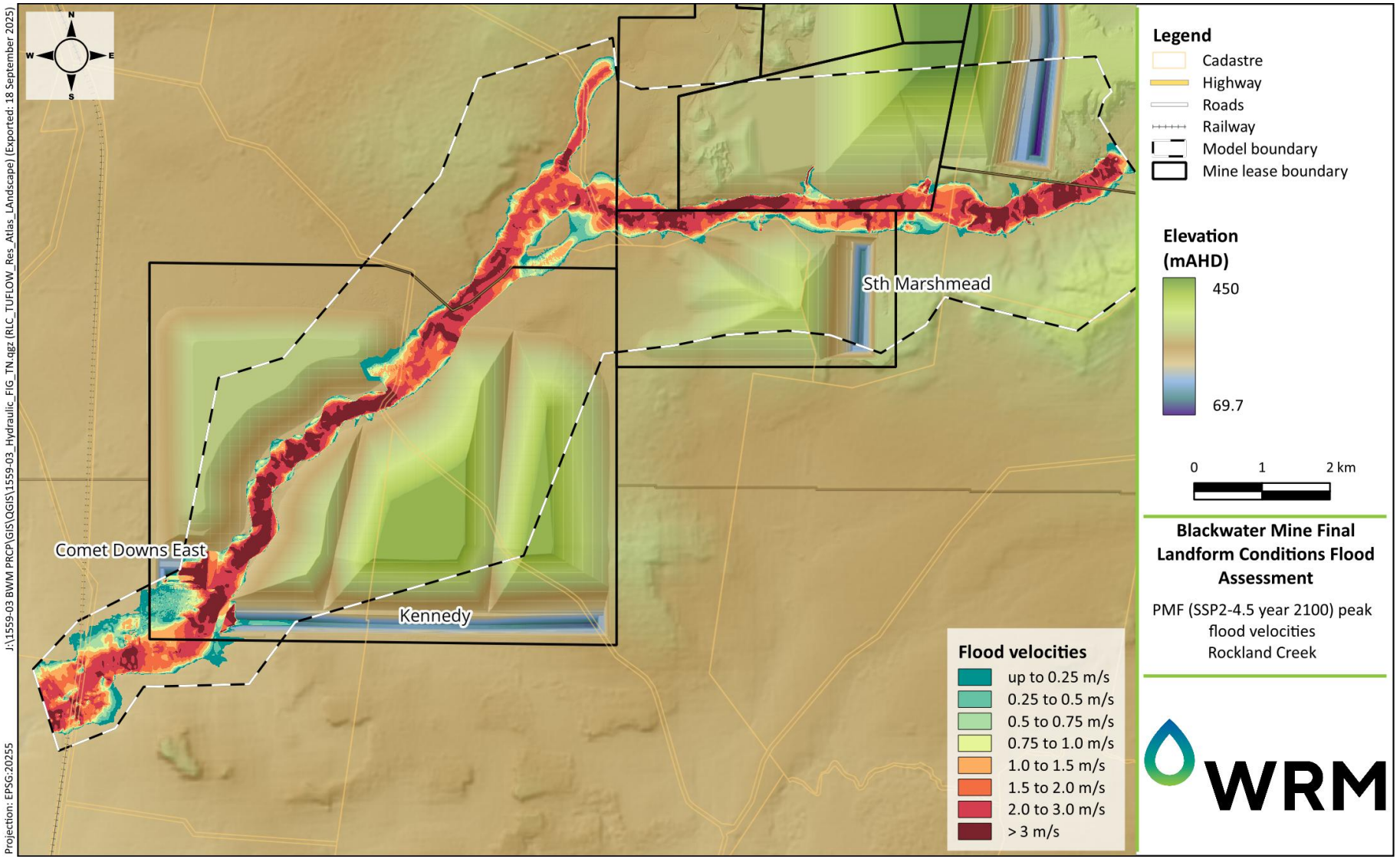


Figure C.32 **Final landform conditions PMF peak flood velocities, Rockland Creek**

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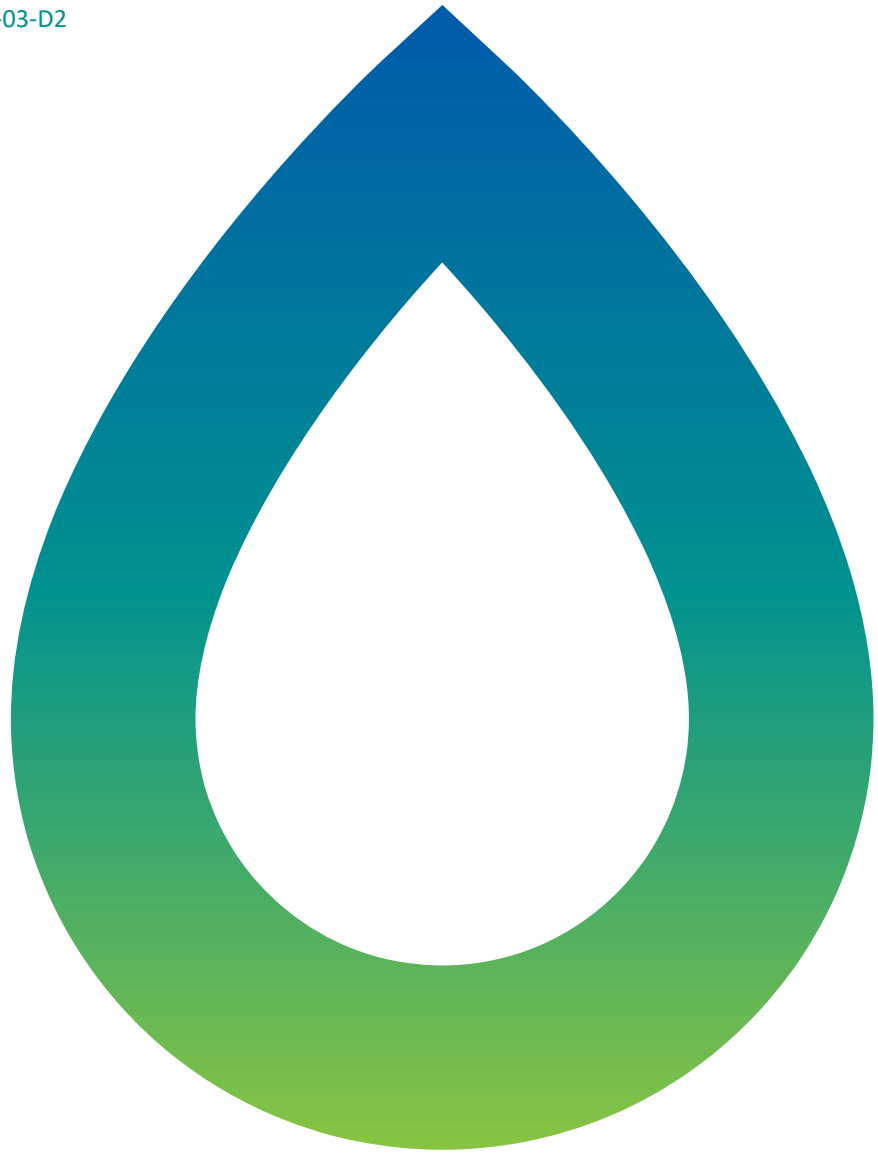
BLACKWATER MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN

Hydrologic Model Development, Calibration and Validation Report

Whitehaven Coal Limited

28 November 2025

1559-03-D2



DETAILS

Report Title	BLACKWATER MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN, Hydrologic Model Development, Calibration and Validation Report
Client	Whitehaven Coal Limited

THIS REVISION

Report Number	1559-03-D2
Date	28 November 2025
Author	Lorena Miranda
Reviewer	Ardianto Notodirdjo

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1 INTRODUCTION

1.1 OVERVIEW

Whitehaven, the owners of Blackwater Mine (BWM), has requested WRM Water & Environment Pty Ltd (WRM) to undertake hydrologic and hydraulic modelling for the BWM Progressive Rehabilitation and Closure Plan (PRCP) for Revision 2 (Rev 2) of the BWM final landform configuration.

New hydrologic models were developed using the URBS software package, which incorporates the latest climate change guidance from Australian Rainfall and Runoff 2019 Version 4.2 (ARR 2019 v4.2) (Ball et al, 2019). Additionally, URBS has increasingly become the industry standard (and preferred) software package for undertaking hydrologic modelling.

This "hydrologic model development report" presents the development, calibration and validation of seven (7) URBS hydrologic models for the catchments that drain across BWM. The modelled catchments are listed below and shown on Figure 1.1:

- Bonnie Doon Creek;
- Sagittarius Creek;
- Burngrove Creek;
- Blackwater Creek (including Deep Creek, Emu Creek, Taurus Creek and Two Mile Gully);
- Speculation Creek;
- Sirius Creek; and
- Rockland Creek.

This report provides the foundation for the following two flood assessments that inform the PRCP for Rev 2 of the BWM final landform:

- The Void in Floodplain Modelling assessment (WRM, 2025a); and
- The Final Landform Flood Modelling Assessment (WRM, 2025b).

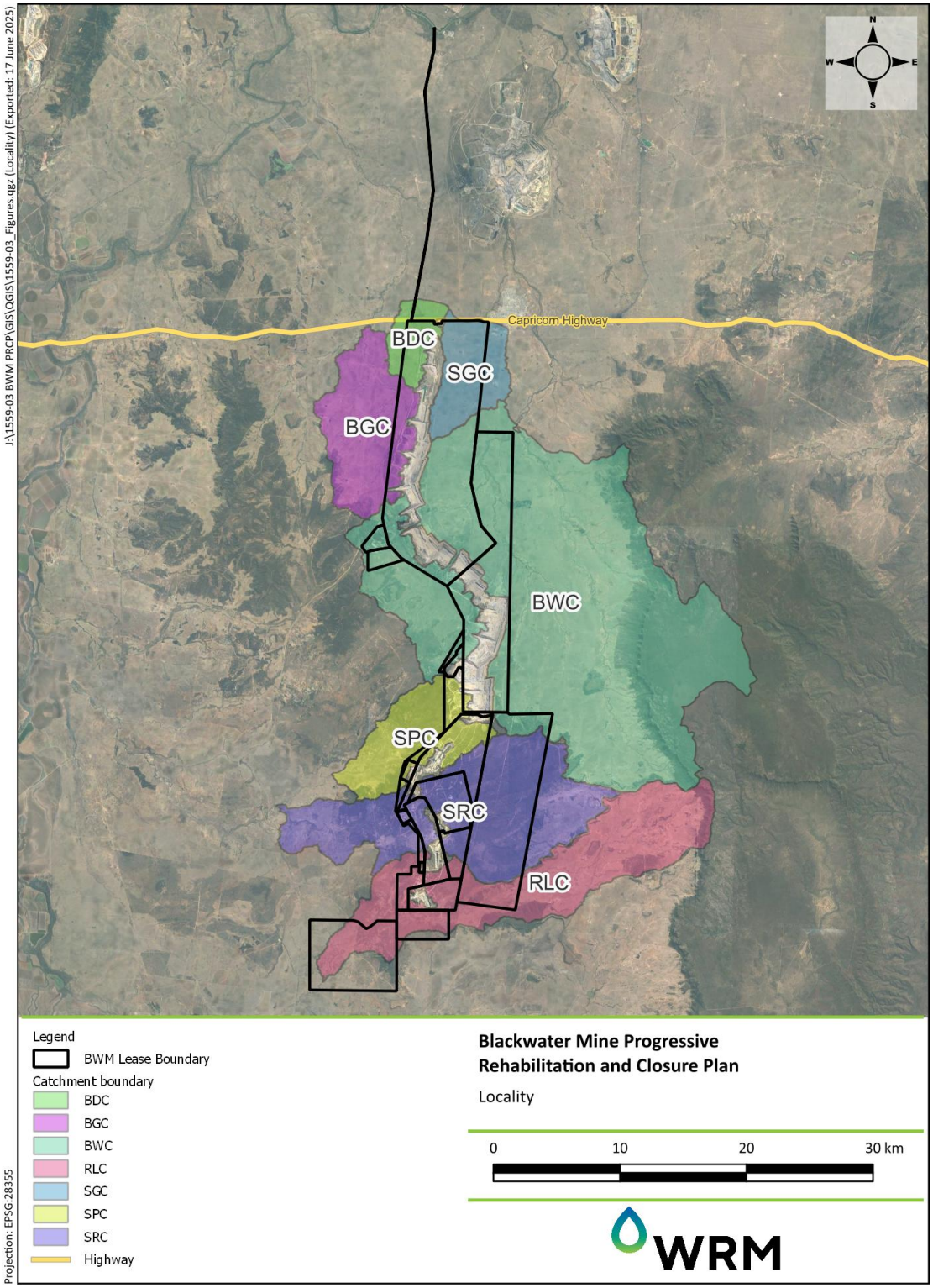


Figure 1.1 Study site locality

1.2 SCOPE OF STUDY

The proposed scope of works for this study included the following tasks:

- Development of a hydrologic model of the Burngrove Creek (BGC) catchment and calibration of the model using recorded water level data at the Burngrove Creek Upstream stream gauge (station 330127);
- Development of a hydrologic model of the Blackwater Creek (BWC) catchment and calibration of the model using recorded water level data at the Taurus Creek Downstream stream gauge (station 330101) and at the Two Mile Gully stream gauge (station 330124);
- Development of a hydrologic model of the Speculation Creek (SPC) catchment and calibration of the model using recorded water level data at the Speculation Creek stream gauge (station 330126);
- Development a hydrologic model of the Sirius Creek (SRC) catchment and calibration of the model using recorded water level data at the Sirius Creek Downstream stream gauge (station 330118), followed by validation of the model predicted 1% (1 in 100) annual exceedance probability (AEP) design discharges against discharge estimates from empirical methods.
- Development of hydrologic models of the Bonnie Doon Creek, Sagittarius Creek and Rockland Creek catchments and validation of the model predicted 1% AEP design discharges against discharge estimates from empirical methods.

1.3 REPORT STRUCTURE

The report is structured as follows:

- Section 2 is an overview of the data available for this study;
- Section 3 describes the development of the hydrologic model;
- Section 4 presents the hydrologic model calibration;
- Section 5 presents the hydrologic model validation;
- Section 6 is a list of references.

2 EXISTING DRAINAGE CHARACTERISTICS

Figure 2.1 shows the existing drainage characteristics in the vicinity of BWM, which are described as follows:

- Bonnie Doon Creek (BDC) drains in a northerly direction west of the BWM workings.
- Sagittarius Creek (SGC) drains in a northerly direction east of the BWM workings.
- The Burngrove Creek (BGC) catchment comprises the following three streams:
    - Burngrove Creek flows in a northeasterly direction west of the BWM workings. A 3 km section of the natural Burngrove Creek channel was removed by the BWM workings and replaced by a diversion channel that drains north between the railway and the BWM.
    - Cabbagetree Creek originates from the southwest of the catchment and drains in a northeasterly direction west of BWM before joining Burngrove Creek.
    - Tolmies Creek originates from the west of the catchment and drains in a northeasterly direction west of BWM before joining Burngrove Creek.
- The Blackwater Creek (BGC) catchment comprises the following five streams:
    - Blackwater Creek originates from the south of the catchment and flows in a northern direction. This creek does not interact with the BWM lease.
    - Taurus Creek, a major tributary of Blackwater Creek, originates from the east of BWM and drains in a northeasterly direction through BWM between the R38S and R42N open cut pits, eventually joining Blackwater Creek about 6 km east of BWM.
    - Deep Creek, a tributary of Taurus Creek, originates from the west of BWM and drains in a northeasterly direction through BWM via the temporary Deep Creek diversion between the R30S and R34S open cut pits, before joining Taurus Creek about 3 km east of BWM.
    - Two Mile Gully, a tributary of Taurus Creek, flows in a northerly direction east of BWM and joins Taurus Creek about 5 km east of BWM.
    - Emu Creek, a tributary of Taurus Creek, originates from the west (upstream) of BWM and flows in a northeasterly direction. It is then diverted in a northwesterly direction via the Emu Creek Diversion, which drains to Taurus Creek just upstream (west) of BWM.
- Speculation Creek (SPC) originates from the western extents of BWM and flows in a southwesterly direction away from BWM. The upper extents of the Speculation Creek catchment have been heavily disturbed by BWM mining operations.
- Sirius Creek originates from the east (upstream) of BWM. It flows in a westerly direction through BWM via the temporary Sirius Creek diversion between the R74 and R78N open cut pits. Downstream of the Sirius Creek Diversion, Sirius Creek continues to drain in a westerly direction away from BWM.
- Rockland Creek originates from the east (upstream) of the BWM. It flows in a westerly direction through BWM and south of the R82S open cut pit. Rockland Creek drains into Rockland Dam just upstream (east) of the mine.
    - Rockland Dam is formed by an earthen embankment across the Rockland Creek channel and floodplain. Rockland Dam is a free-draining structure, with a low-flow culvert outlet at the base of the dam and an overflow spillway weir and channel at the northern end of the dam.

- Table 2.1 shows the key characteristics of Rockland Dam obtained from the *Rockland Creek Diversion Construction Report* (PPK Consultants, 1994), the GHD (2021) report and the 2024 LiDAR data.

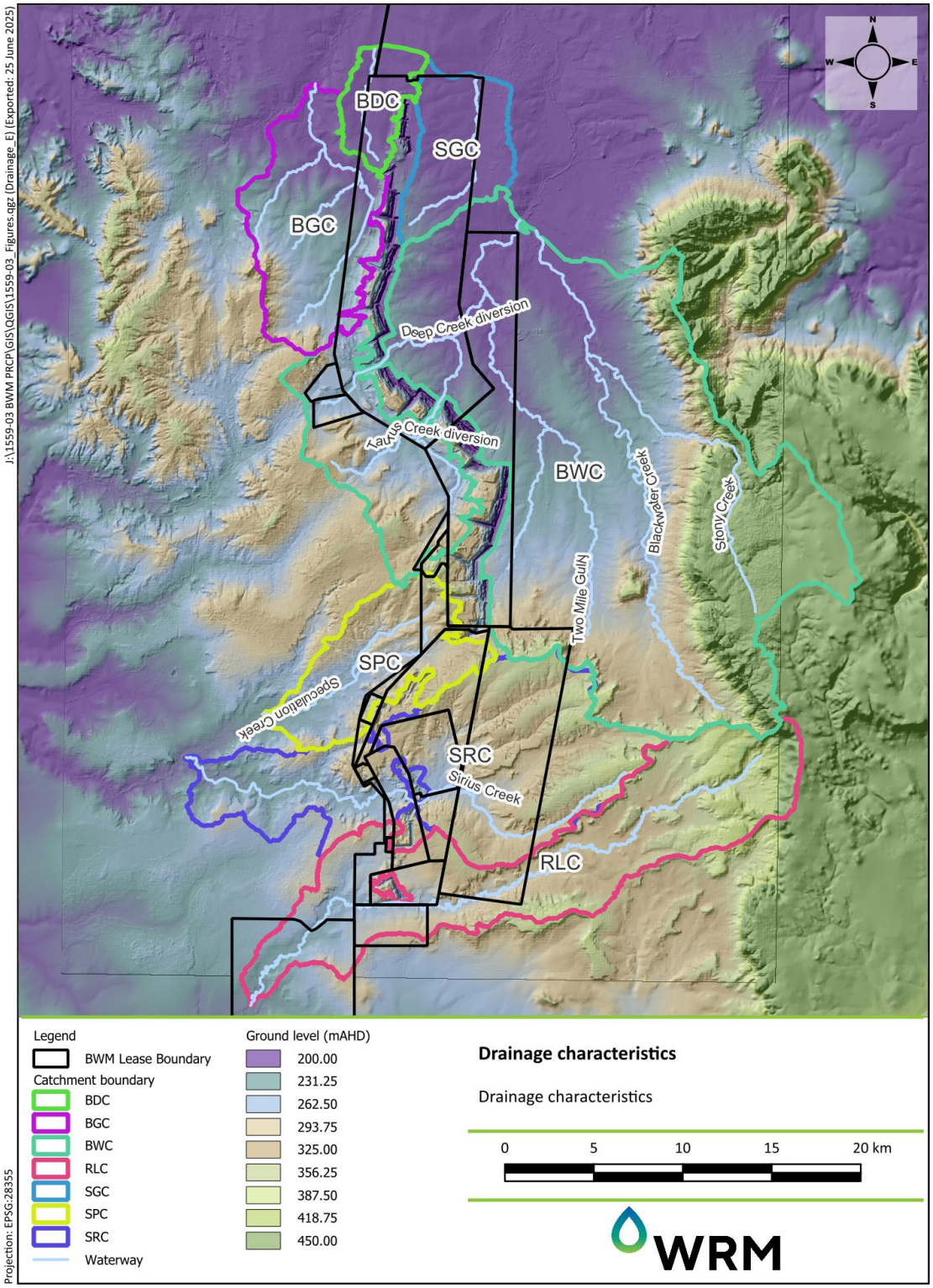


Figure 2.1 Study site drainage characteristics

- Figure 2.2 shows the stage-storage relationship for the dam derived from the LiDAR topographic data obtained in 2024. Figure 2.3 shows the stage-discharge relationship of the dam outlet derived from TUFLOW hydraulic model results.

Table 2.1 Rockland Dam key details

Dam feature	Value	Comment
Dam crest	281.2 mAHD	Based on 2024 LiDAR data
Dam crest width	8 m	Based on PPK (1994) construction report
Embankment height	16.1 m	Based on GHD (2021) report
Spillway invert	278.7 mAHD	Based on 2024 LiDAR data
Spillway width at crest	50 m	Based on GHD (2021) report
Outlet works	1.68 m wide and 1.95 m high box culverts Inlet invert = 263.4 mAHD Outlet invert = 262.8 mAHD	Based on GHD (2021) report
Storage volume at crest	20,310 ML	Based on PPK (1994) construction report

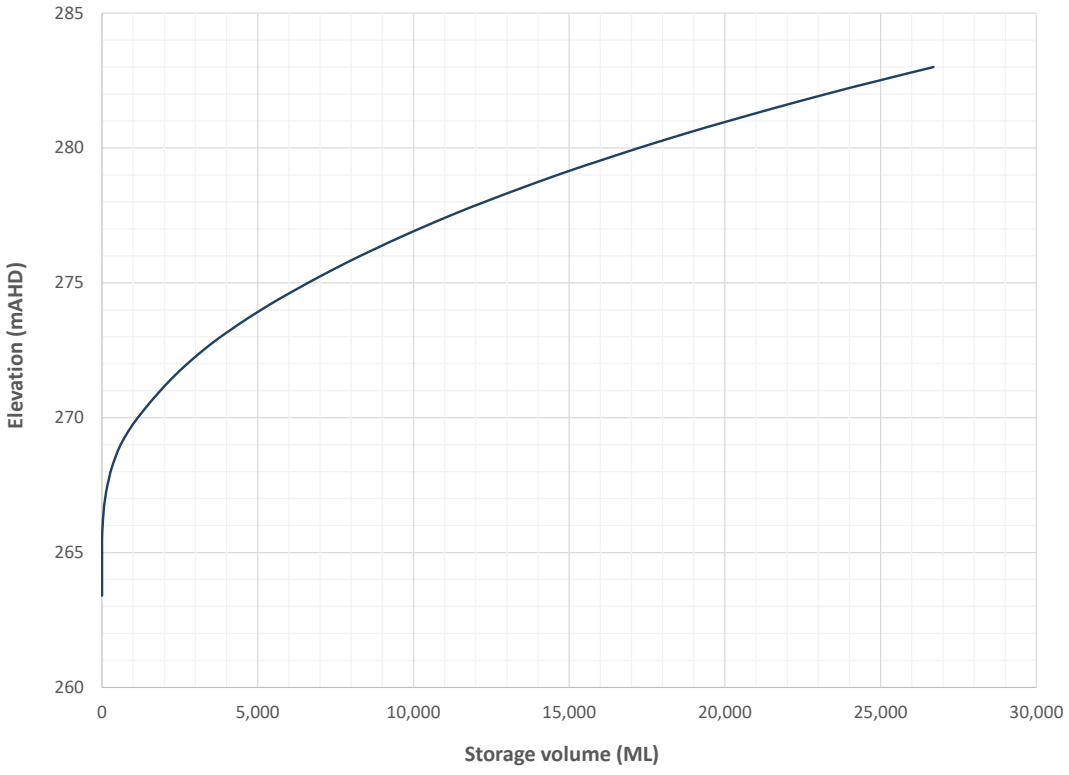


Figure 2.2 Stage-storage relationship for Rockland Dam

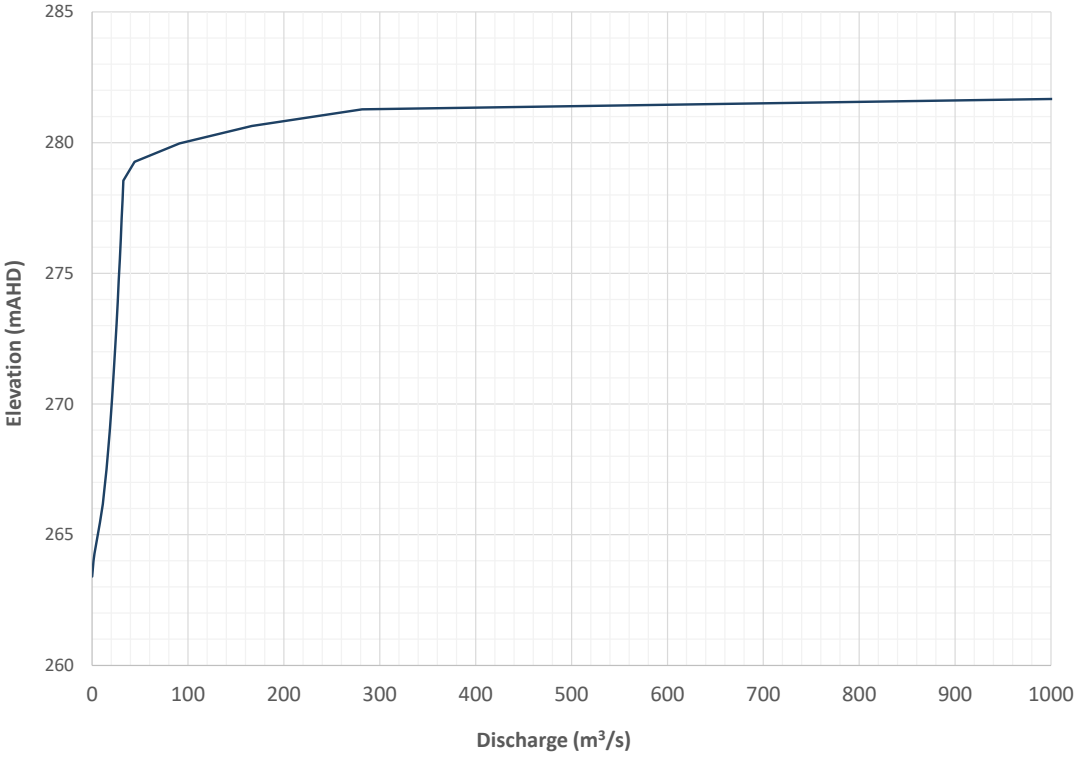


Figure 2.3 Stage-discharge relationship for the Rockland Dam outlet

3 AVAILABLE DATA

3.1 OVERVIEW

The following data was provided by Whitehaven for this study:

- Previous hydrologic and hydraulic studies;
- Recorded rainfall and water level data; and
- LiDAR topographic data.

3.2 PREVIOUS STUDIES

3.2.1 Blackwater Mine Flood Study (2021)

The Blackwater Mine Flood Study undertaken by GHD (2021) assessed existing flood risks across BWM. XP-RAFTS hydrologic and TUFLOW hydraulic models were developed for this study. In this study, the hydrologic models for Burngrove Creek and Speculation Creek were calibrated to recorded water level data. The GHD (2021) study report was provided for this study, but the XP-RAFTS and TUFLOW models were not available.

3.2.2 Blackwater Mine Progressive Rehabilitation and Closure Plan (2024)

The XP-RAFTS hydrologic and TUFLOW hydraulic models used by SLR (2024a and 2024b) for the Rev 1 PRCP flood assessment were provided for this study. These models appear to have been developed based on the GHD (2021) hydrologic and hydraulic models. Separate models were provided for the following catchments:

- Bonnie Doon Creek;
- Blackwater Creek;
- Burngrove Creek;
- Rockland Creek;
- Sagittarius Creek;
- Sirius Creek;
- Speculation Creek;
- Taurus Creek; and
- Two Mile Gully.

3.3 RAINFALL AND WATER LEVEL DATA

3.3.1 Rainfall and water level gauging stations

Figure 3.1 shows the location of three subdaily rainfall (pluviograph) stations and six stream gauging stations across BWM. Table 3.1 and Table 3.2 show details of these stations.

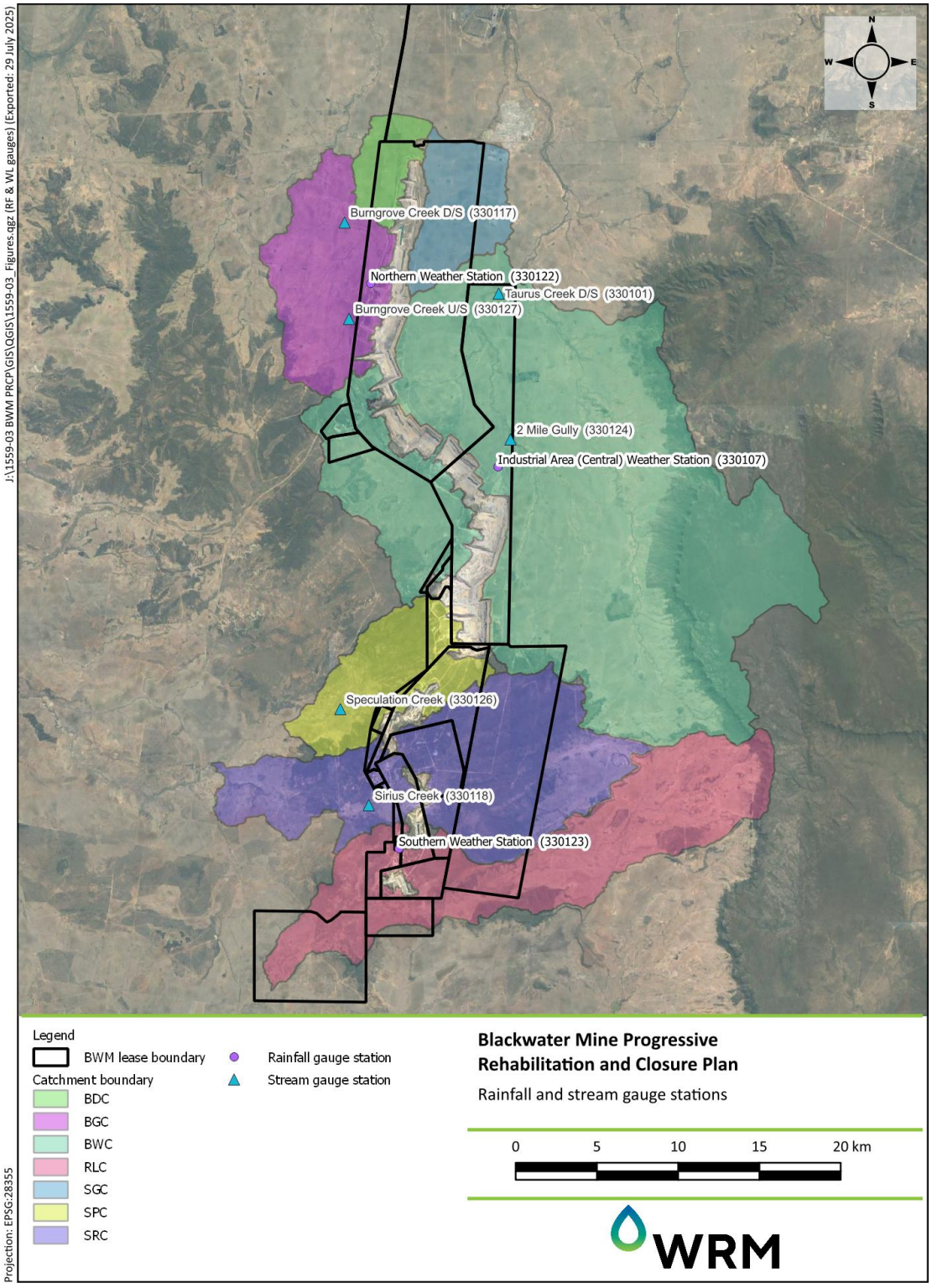


Figure 3.1 Location of rainfall and stream gauging stations

Table 3.1 Details of available subdaily rainfall (pluviograph) stations

Station Number	Station Name	Supplied data period
330122	Northern Weather Station	January 2016 – January 2025
330107	Industrial Areal (Central) Weather Station	January 2016 – January 2025
330123	Southern Weather Station	January 2016 – January 2025

Table 3.2 Details of available stream gauging stations

Station Number	Station Name	Supplied data period
330101	Taurus Creek D/S	January 2016 – January 2025
330118	Sirius Creek D/S	January 2016 – January 2025
330124	Two Mile Gully	January 2016 – January 2025
330126	Speculation Creek	January 2016 – January 2025
330127	Burngrove Creek U/S	January 2016 – January 2025
330117	Burngrove Creek D/S	January 2016 – January 2025

3.3.2 Rating curves

Whitehaven provided rating curves for the six gauges listed in Table 3.2 (referred to in this report as the Whitehaven rating curves). It was uncertain if the Whitehaven rating curves were derived from actual gaugings or from hydraulic modelling. For this study, the rating curves were verified and then modified and/or extended if necessary, using hydraulic modelling where detailed LiDAR data is available.

Figure 3.1 to Figure 3.4 compare the Whitehaven rating curves, the TUFLOW model generated rating curves and the final adopted rating curves for the Taurus Creek D/S, Two Mile Gully, Burngrove Creek U/S and Sirius Creek D/S gauges, respectively. For these four gauges, the “adopted” rating curves were used to convert recorded water levels into discharges for the hydrologic model calibration.

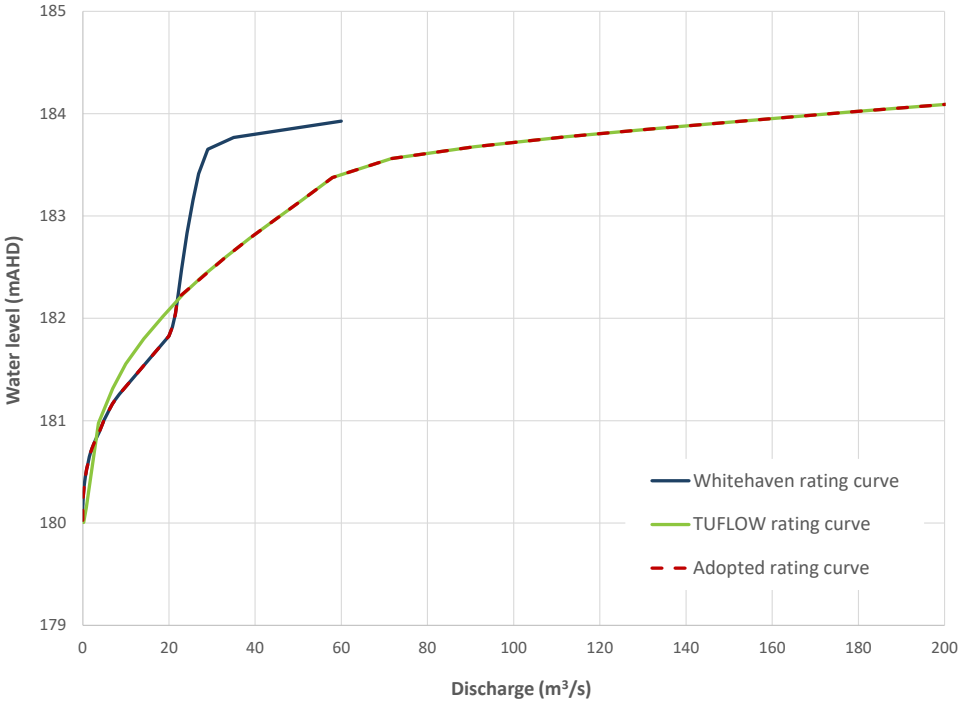


Figure 3.1 Comparison of Whitehaven-supplied, TUFLOW and adopted rating curves, Taurus Creek D/S gauging station

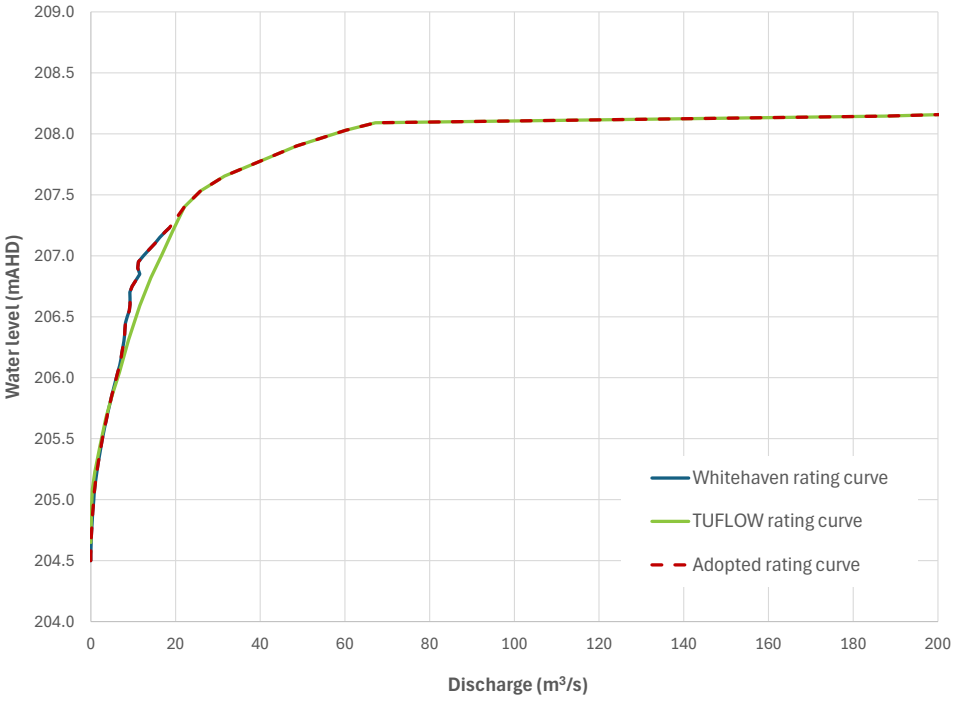


Figure 3.2 Comparison of Whitehaven-supplied, TUFLOW and adopted rating curves, Two Mile Gully gauging station

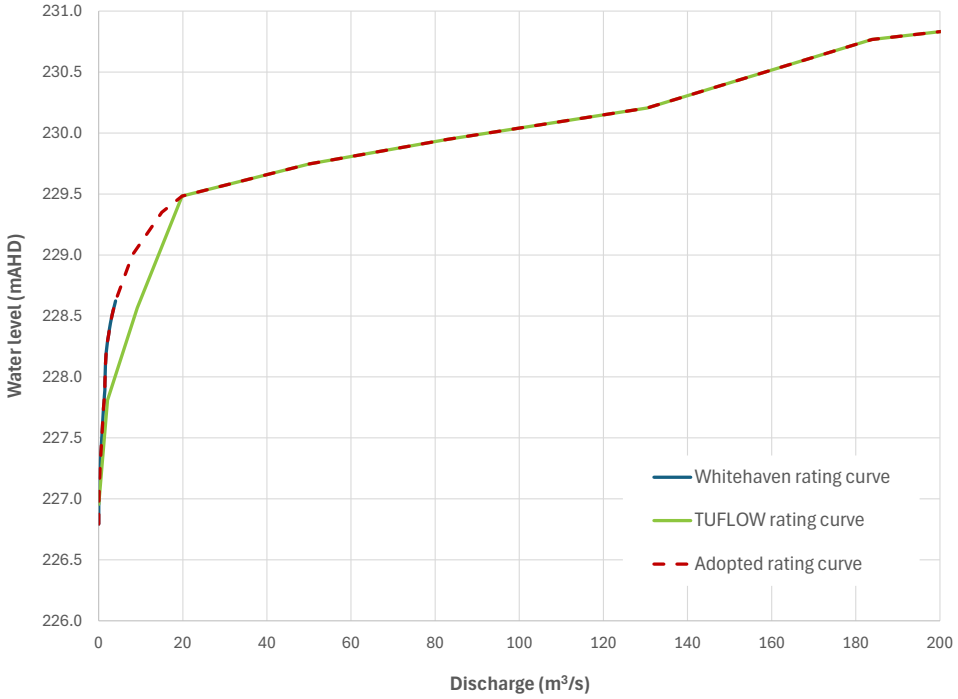


Figure 3.3 Comparison of Whitehaven-supplied, TUFLOW and adopted rating curves, Burngrove Creek U/S gauging station

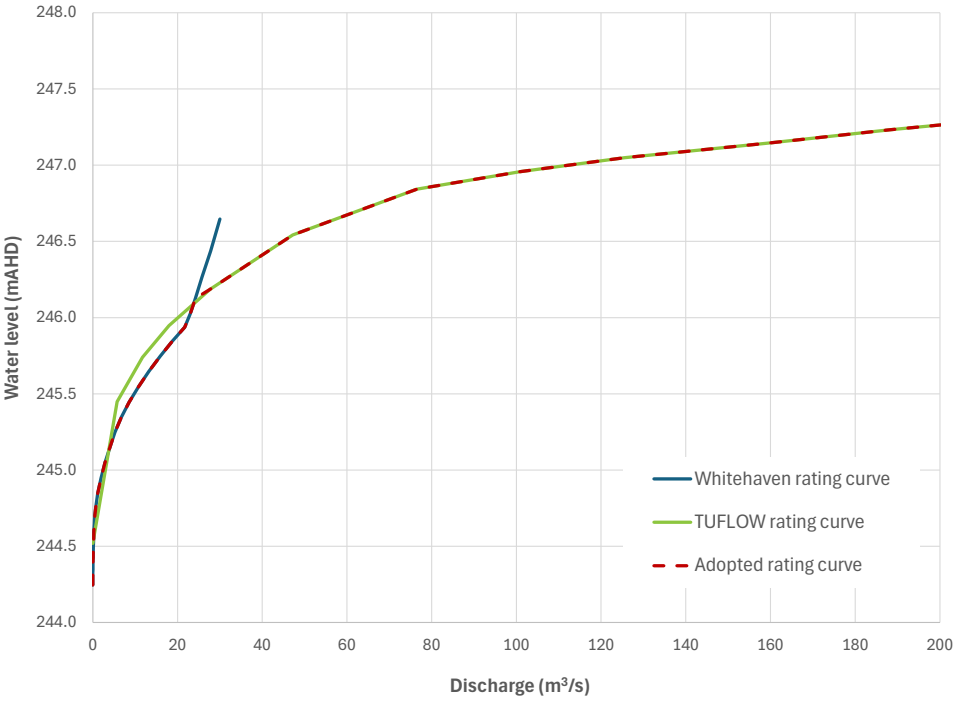


Figure 3.4 Comparison of Whitehaven-supplied, TUFLOW and adopted rating curves, Sirius Creek D/S gauging station

3.4 TOPOGRAPHIC DATA

The available topographic data used for this study is described as follows:

- A 1 m resolution LiDAR covering the BWM mine lease area captured in February 2024 (referred to as the 2024 LiDAR data);
- A 1 m resolution LiDAR covering the active mining pits of BWM captured in February 2025 (referred to as the 2025 LiDAR data); and
- A 30 m resolution Copernicus Digital Surface Model (DSM) satellite ground level observation data obtained from the European Space Programme on 31 January 2025 (referred to as the Copernicus DSM data).

4 HYDROLOGIC MODEL DEVELOPMENT

4.1 OVERVIEW

A total of seven URBS hydrologic models were developed for the following catchments:

- Bonnie Doon Creek;
- Blackwater Creek (including Taurus Creek and Two Mile Gully);
- Burngrove Creek;
- Rockland Creek;
- Sagittarius Creek;
- Sirius Creek;
- Speculation Creek.

URBS is a runoff-routing computer model that uses a network of conceptual storages to represent the routing of rainfall excess through a catchment. The URBS model was used in the "split mode" which enables the separate simulation of catchment and channel routing.

The initial and continuing loss method was adopted for this study. This model assumes that there is an initial loss (IL) in mm before any rainfall becomes runoff. After this, a continuing loss (CL) rate in mm per hour is applied to the rainfall.

Full details of the URBS model and its features are given in the URBS User Manual (Carroll, 2021).

The following three models were calibrated to recorded data for the March 2017 and January 2020 flood events:

- Burnrgrove Creek;
- Blackwater Creek (including Taurus Creek and Two Mile Gully);
- Sirius Creek.

The above three models were selected for calibration due to due to having stream gauging stations located in areas where detailed LiDAR data is available. This allowed for the rating curves to be verified using hydraulic model results.

The following is of note with regard to the remaining four models:

- Bonnie Doon Creek, Sagittarius Creek and Rockland Creek – There are no stream gauging stations within this catchment and hence, a model calibration cannot be undertaken for this catchment.
- Speculation Creek – The supplied rating curve for the Speculation Creek D/S gauge does not capture the peak flows that occurred in the March 2017 and January 2020 events. In addition, the Speculation Creek D/S gauging station is located outside of the detailed 2024 LiDAR data extent and as such, the supplied rating curve cannot be verified using hydraulic modelling.

The URBS models were then used to estimate design discharges for the 1% AEP event. The 1% AEP design discharge estimates were validated against estimates derived using the Rational Method, the Quantile Regression Technique (QRT) and the Regional Flood Frequency Estimation (RFFE) method.

4.2 MODEL CONFIGURATION

4.2.1 Subcatchment parameters

The URBS model subcatchments were assigned with area, slope, imperviousness, and PERN parameters. Subcatchment slopes were calculated using based on the available topographic data. The spatial configuration of the seven URBS models are summarised below.

4.2.1.1 Bonnie Doon Creek (BDC)

Figure A.1 in Appendix A shows the URBS model subcatchments adopted for the BDC model. The model covers an area of 21.6 km^2 and consists of 18 subcatchments, ranging in size from 0.17 km^2 to 2.46 km^2. Table A.1 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.2 Sagittarius Creek (SGC)

Figure A.2 in Appendix A shows the URBS model subcatchments adopted for the SGC model. The model covers a catchment area of 42.7 km^2 and consists of 28 subcatchments, ranging in size from 0.02 km^2 to 3.34 km^2. Table A.2 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.3 Burngrove Creek (BGC)

Figure A.3 in Appendix A shows the URBS model subcatchments adopted for the BGC model. The model covers an area of 79.2 km^2 and consists of 54 subcatchments, ranging in size from 0.06 km^2 to 5.72 km^2. Table A.3 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.4 Blackwater Creek (BWC)

Figure A.4 in Appendix A shows the URBS model subcatchments adopted for the BWC model. The model covers an area of 509.8 km^2 and consists of 226 subcatchments, ranging in size from 0.02 km^2 to 17.8 km^2. Table A.4 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.5 Speculation Creek (SPC)

Figure A.5 in Appendix A shows the URBS model subcatchments adopted for the SPC model. The model covers an area of 60.31 km^2 and consists of 39 subcatchments, ranging in size from 0.07 km^2 to 4 km^2. Table A.5 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.6 Sirius Creek (SRC)

Figure A.6 in Appendix A shows the URBS model subcatchments adopted for the SRC model. The model covers an area of 162 km^2 and consists of 85 subcatchments, ranging in size from 0.13 km^2 to 6.15 km^2. Table A.6 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.7 Rockland Creek (RLC)

Figure A.7 in Appendix A shows the URBS model subcatchments adopted for the SRC model. The model covers ant area of 158.6 km^2 and consists of 62 subcatchments, ranging in size from 0.14 km^2 to 8.5 km^2. Table A.7 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.2 Adopted global URBS model parameters

The global URBS model parameters included channel lag parameter (alpha), catchment storage parameter (beta), catchment non-linearity (M) and channel routing exponent (N). The following global URBS parameters were adopted for all seven models:

- Channel routing “alpha” (α) = 0.1
- Catchment routing “beta” (β) = 1.0
- Catchment routing exponent (M) = 0.715
- Channel routing exponent (N) = 1.0

4.3 INITIAL AND CONTINUING LOSSES

The initial loss (IL) and continuing loss (CL) method of accounting for rainfall losses was adopted for this study. For the calibration events, different initial and continuing losses were derived for each calibration event to reflect different antecedent catchment conditions (refer to Section 5.3). Design event ILs and CLs were derived during the model validation process (refer to Section 6.2.2).

5 HYDROLOGIC MODEL CALIBRATION

5.1 METHODOLOGY

The URBS models for the Burngrove Creek, Blackwater Creek and Sirius Creek were calibrated for the March 2017 and January 2020 flood events. The purpose of the model calibration was to achieve the best possible match between URBS-modelled discharge hydrographs against the recorded discharge hydrographs, using a common set of model parameters between flood events.

5.2 SELECTION OF CALIBRATION EVENTS

5.2.1 Overview

The March 2017 and January 2020 flood events were selected for calibration due to the availability of data and because the rainfalls during these events triggered similar responses at all catchments for which data is available. The March 2017 and January 2020 events were also the selected calibration events in the GHD (2021) study.

Table 5.1 shows the adopted historical event simulation periods for the calibration events in the URBS model. Table 5.2 shows the recorded rainfall depths at each station for the calibration events. Table 5.3 shows the recorded peak discharges at each gauging station for the calibration events.

Table 5.1 Calibration event simulation periods

Calibration Event	Simulation period
March 2017	28 March (0000 hours) – 1 April (0000 hours) - 4 days
January 2020	24 January (0000 hours) – 27 January (0000 hours) - 3 days

Table 5.2 Total rainfall depths recorded during the 2017 and 2020 events

Station Number	Station Name	Rainfall depth (mm)	
		March 2017	January 2020
330107	Central WS	119.0	148.0
330122	Northern WS	139.5	78.5
330123	Southern WS	142.5	49.5

Table 5.3 Peak discharges recorded during calibration events

Station Number	Station Name	Peak discharge (m^3/s)	
		March 2017	January 2020
330127	Burngrove Creek U/S	78.5	22.2
330101	Taurus Creek D/S	117	156.8
330124	Two Mile Gully	16.2	50.4
330118	Sirius Creek D/S	15.9	8.6

5.2.2 March 2017 event

Figure B.1 to Figure B.3 (Appendix B) show the rainfall intensity recorded at each available rainfall station listed in Table 5.2 over the period 0000 hours on 28 March 2017 to 0000 hours on 1 April 2017 within and near the catchments of interest. The highest rainfall intensity of 29 mm/h was recorded in the at the Southern WS Station (330123).

Figure B.4 to Figure B.8 (Appendix B) shows the recorded water levels at the stations listed in Table 5.3 over the same period.

5.2.3 January 2020 event

Figure B.9 to Figure B.11 (Appendix B) show the rainfall intensity recorded at each available rainfall station listed in Table 5.2 over the period 0000 hours on 24 January 2020 to 0000 hours on 27 January 2020 within and near the catchments of interest. The highest rainfall intensity of 46 mm/h was recorded at the Central WS Station (330107).

Figure B.12 to Figure B.16 (Appendix B) shows the recorded water levels at the stations listed in Table 5.3 over the same period.

5.2.4 Assignment of subcatchment rainfalls

Each URBS subcatchment was assigned a rainfall hyetograph based on the three nearest pluviograph stations, using the URBS SUBRAIN utility. The SUBRAIN utility calculates the weighted average rainfall depth for each subcatchment using an inverse distance squared method based on the relative distance between the rainfall station location and the subcatchment centroid.

5.3 INITIAL AND CONTINUING LOSSES

Table 5.4 shows the IL and CL adopted for the Blackwater Creek, Burngrove Creek and Sirius Creek catchments for the two calibration events. A CL of 3.5 mm/h was adopted for all three models and for all events. Different ILs were adopted for each model and for each event which reflect the different antecedent conditions prior to each event.

Table 5.4 Adopted initial and continuing losses

Model	March 2017		January 2020	
	IL (mm)	CL (mm/h)	IL (mm)	CL (mm/h)
BGC	52	3.5	53	3.5
BWC	82	3.5	75	3.5
SRC	125	3.5	73	3.5

5.4 MODEL CALIBRATION RESULTS

5.4.1 Overview

Table 5.5 shows the comparison of the calculated and recorded peak discharges at the four gauging stations for the 2017 and 2020 events.

Table 5.5 Summary of calibration results

Station Number	Station Name	Peak discharge (m^3/s)					
		March 2017			January 2020		
		Calculated	Recorded	Difference (%)	Calculated	Recorded	Difference (%)
330127	Burngrove Creek U/S	57.4	56.5	1.5%	22.5	22.2	1%
330101	Taurus Creek D/S	116.6	117.0	-0.3%	155.6	156.8	-1%
330124	Two Mile Gully	46.9	16.2	189.4%	79.1	50.4	57%
330118	Sirius Creek D/S	12.2	11.9	2.3%	9.0	8.6	4%

5.4.2 March 2017 event calibration results

Figure 5.1 to Figure 5.4 compare the modelled / calculated (C) and recorded (R) discharge hydrographs for the March 2017. The calibration results for the March 2017 event are summarised below.

- In Burngrove Creek, the calibration is considered good, with the modelled (calculated) hydrograph matching well with the recorded hydrograph peak, shape and timing at the Burngrove Creek U/S gauge.
- In Taurus Creek and Two Mile Gully:
  - The modelled (calculated) hydrograph matches well with the recorded hydrograph peak and shape at the Taurus Creek D/S gauge. However, the URBS model could not reproduce the recorded hydrograph shape, peak or timing further upstream at the Two Mile Gully gauge.
  - The recorded data suggests that the Two Mile Gully gauge appears to have malfunctioned during the event, as indicated by the following:

- The recorded water level hydrograph shape at the Two Mile Gully gauge is inconsistent with the recorded water levels at the Taurus Creek gauge (refer to Figure B.5 and B.6 in Appendix B).
- The catchment area to Two Mile Gully is around 27% of the catchment area to the Taurus Creek D/S gauge. Despite this, the recorded peak discharge at Two Mile Gully D/S is only 14% of the recorded peak discharge at Taurus Creek D/S. This indicates that the Two Mile Gully gauge likely did not capture the peak water level (and hence the peak discharge) during this event.
- In consideration of the above, the calibration in Two Mile Gully and Taurus Creek is considered acceptable.

- In Sirius Creek:
  - The modelled (calculated) hydrograph generally matches the recorded hydrograph shape and peak, but the timing of the modelled flood peak is significantly delayed compared to the recorded peak.
  - The reason for the discrepancy in timing between the modelled and recorded flood peak is uncertain. The catchment area to the Sirius Creek gauge is around 120 km^2 and on this basis, the flood peak is expected to occur much later than what the data is suggesting, similar to observations at the Taurus Creek and Two Mile Gully gauges for this event. This suggests that there could be an issue with the timing of the recorded water levels at the Sirius Creek gauge, but further investigation is required to confirm this.
  - In consideration of the above, the calibration in Sirius Creek is considered acceptable.

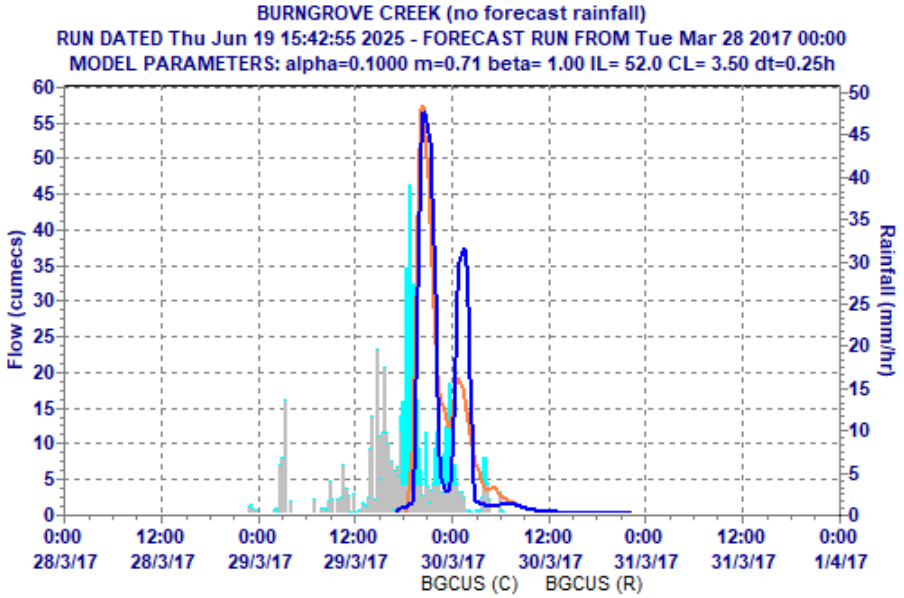


Figure 5.1 Calculated (C) and recorded (R) discharge hydrographs for March 2017 event at Burngrove Creek

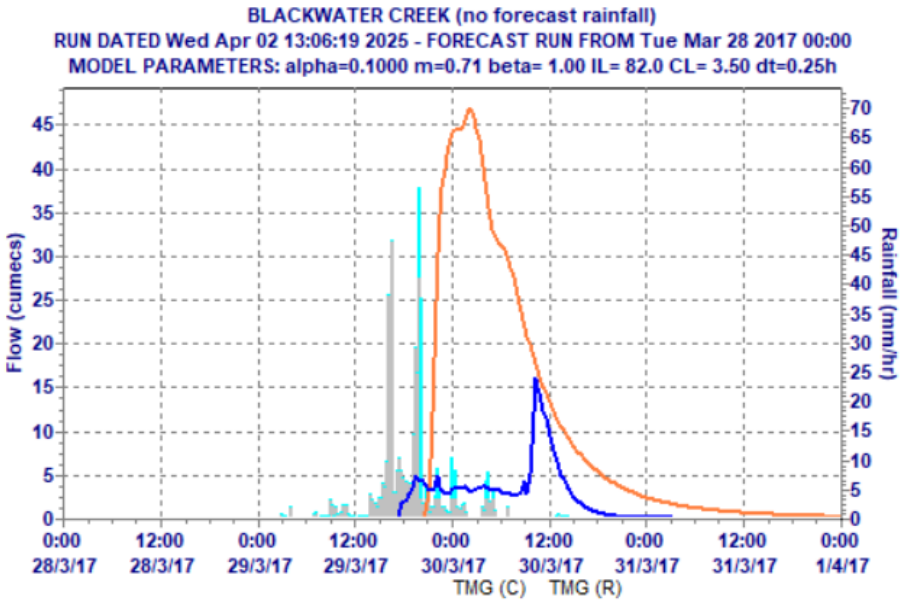


Figure 5.2 Calculated (C) and recorded (R) discharge hydrographs for March 2017 event at Two Mile Gully

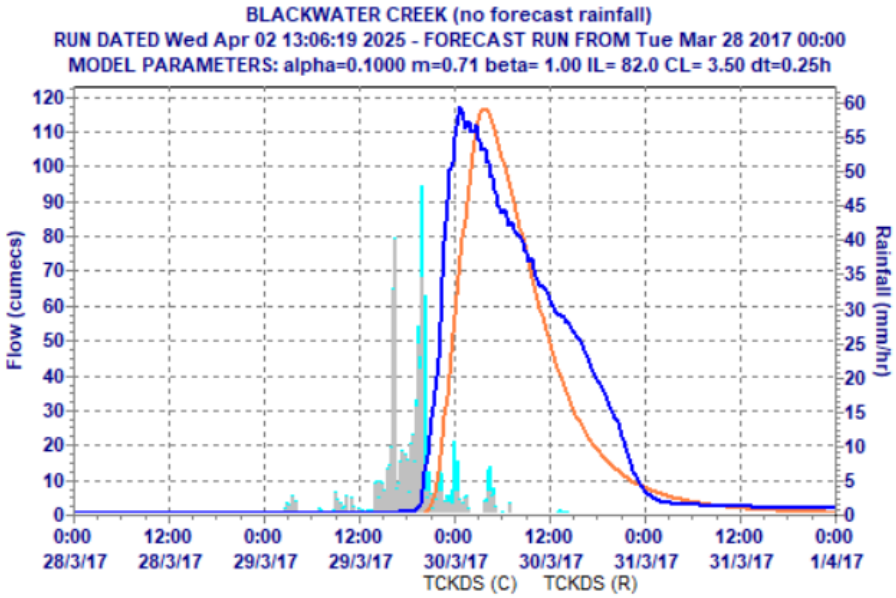


Figure 5.3 Calculated (C) and recorded (R) discharge hydrographs for March 2017 event at Taurus Creek

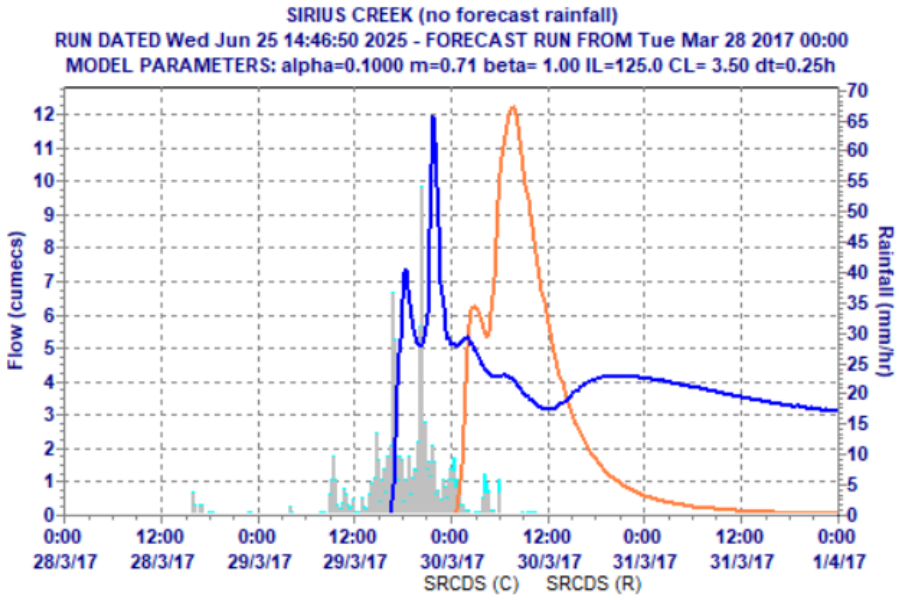


Figure 5.4 Calculated (C) and recorded (R) discharge hydrographs for March 2017 event at Sirius Creek

5.4.3 January 2020 event calibration results

Figure 5.5 to Figure 5.4 compare the modelled / calculated (C) and recorded (R) discharge hydrographs for the March 2017. The calibration results for the March 2017 event are summarised below

- In Burngrove Creek, the calibration is considered good, with the modelled (calculated) hydrograph matching well with the recorded hydrograph peak, shape and timing at the Burngrove Creek U/S gauge.
- In Taurus Creek and Two Mile Gully:
  - The modelled (calculated) hydrograph matches well with the recorded hydrograph peak and shape at the Taurus Creek D/S gauge. However, the URBS model could not reproduce the recorded hydrograph shape, peak or timing further upstream at the Two Mile Gully gauge.
  - Compared to the March 2017 event, there are similar discrepancies observed between the recorded water level hydrographs at Two Mile Gully and Taurus Creek D/S for the January 2020 event. This suggests that the Two Mile Gully gauge may not have accurately captured the peak flood level (and hence the peak discharge) during the January 2020 event, due to similar reasons described in Section 5.4.2 for the March 2017 event.
  - In consideration of the above, the calibration in Two Mile Gully and Taurus Creek is considered acceptable.
- In Sirius Creek:
  - The modelled (calculated) hydrograph generally matches the recorded hydrograph shape and peak, but the timing of the modelled flood peak is significantly delayed compared to the recorded peak.
  - The reason for the discrepancy in timing between the modelled and recorded flood peak is uncertain, but it is similar to the calibration results for the March 2017 event at this gauge

(refer to Section 5.4.2). This further suggests that there could be an issue with the timing of the recorded water levels at the Sirius Creek gauge, but further investigation is required to confirm this.

- In consideration of the above, the calibration in Sirius Creek is considered acceptable.

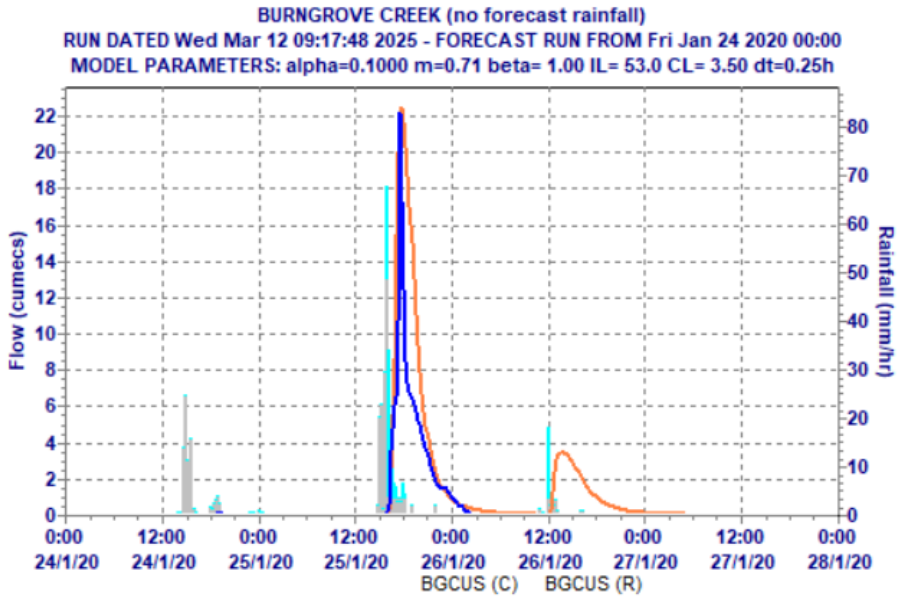


Figure 5.5 Calculated (C) and recorded (R) discharge hydrographs for January 2020 event at Burngrove Creek

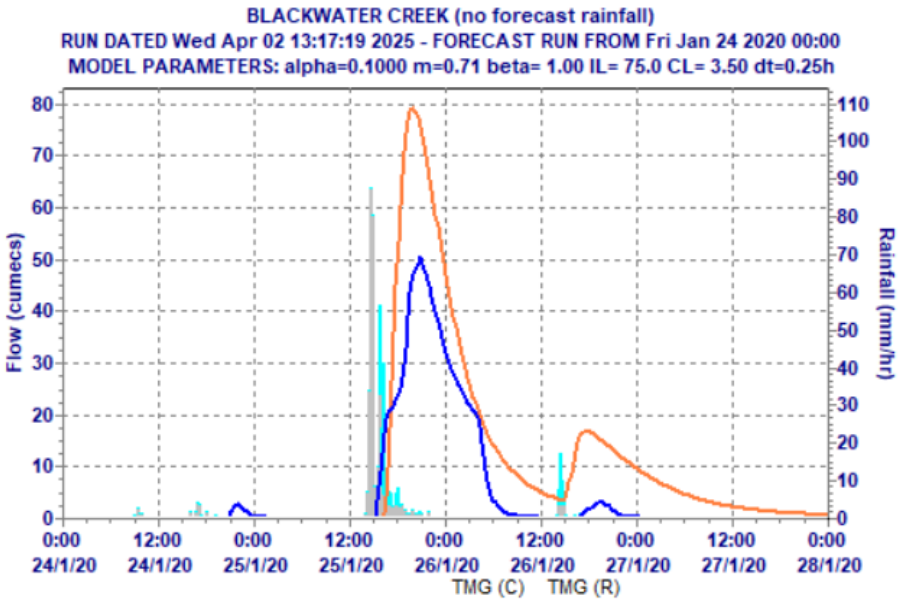


Figure 5.6 Calculated (C) and recorded (R) discharge hydrographs for January 2020 event at Two Mile Gully

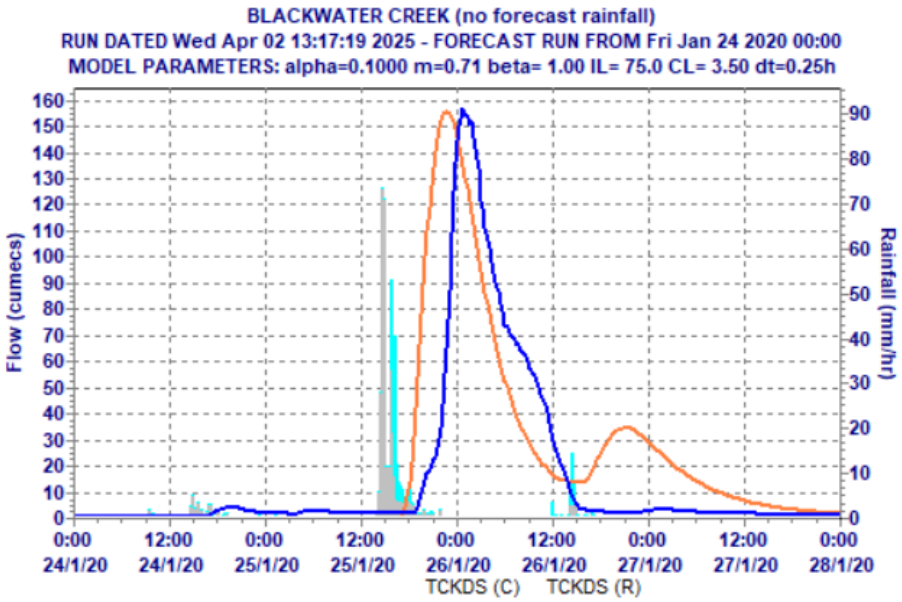


Figure 5.7 Calculated (C) and recorded (R) discharge hydrographs for January 2020 event at Taurus Creek

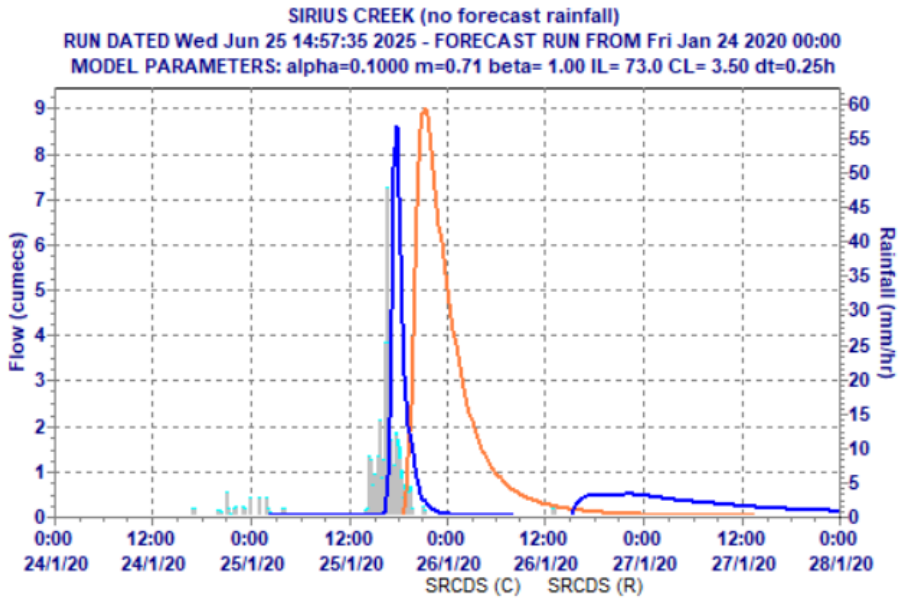


Figure 5.8 Calculated (C) and recorded (R) discharge hydrographs for January 2020 event at Sirius Creek

6 DESIGN DISCHARGE ESTIMATION AND VALIDATION

6.1 METHODOLOGY

URBS model design discharge estimates for all seven models were validated against discharge estimates derived using the Rational Method (RM), the Quantile Regression Technique (QRT) (Palmen and Weeks, 2015) and the Regional Flood Frequency Analysis (RFFE) method. Design peak discharges were validated for the 1% AEP event only, at key validation locations shown in Figure 6.1, which were selected to allow comparison of design discharges from all of the above-mentioned methods at the same location.

6.2 URBS MODEL PARAMETERS

6.2.1 Global model parameters

The global URBS model parameters (alpha, beta, M and N) given in Section 4.2.2 were adopted for design event modelling for all models.

6.2.2 Initial and continuing losses

Table 6.1 shows the ILs and CLs adopted for 1% AEP design event in each model.

The design event ILs are generally lower than those adopted for the calibration events (refer to Section 5.3). This reflects the high degree of catchment saturation that is expected prior to the main rainfall burst during rare events such as the 1% AEP. In comparison, the March 2017 and January 2020 calibration events were much smaller and more frequent events than a 1% AEP design event.

The adopted CLs for the seven models are generally consistent with the calibration event CLs (3.5 mm/h) except for the Rockland Creek and Sagittarius Creek models. Lower CLs were adopted for these models to achieve a better match between URBS model peak discharges and those derived from empirical methods.

Table 6.1 Adopted design event initial and continuing losses for the 1% AEP event

URBS Model	1% AEP losses	
	IL (mm)	CL (mm/h)
Bonnie Doon Creek (BDC)	5	3.5
Burngrove Creek (BGC)	35	3.5
Sagittarius Creek (SGC)	0	2
Blackwater Creek (BWC)	0	3.5
Speculation Creek (SPC)	0	3.5
Sirius Creek (SRC)	50	3.5
Rockland Creek (RLC)	0	2

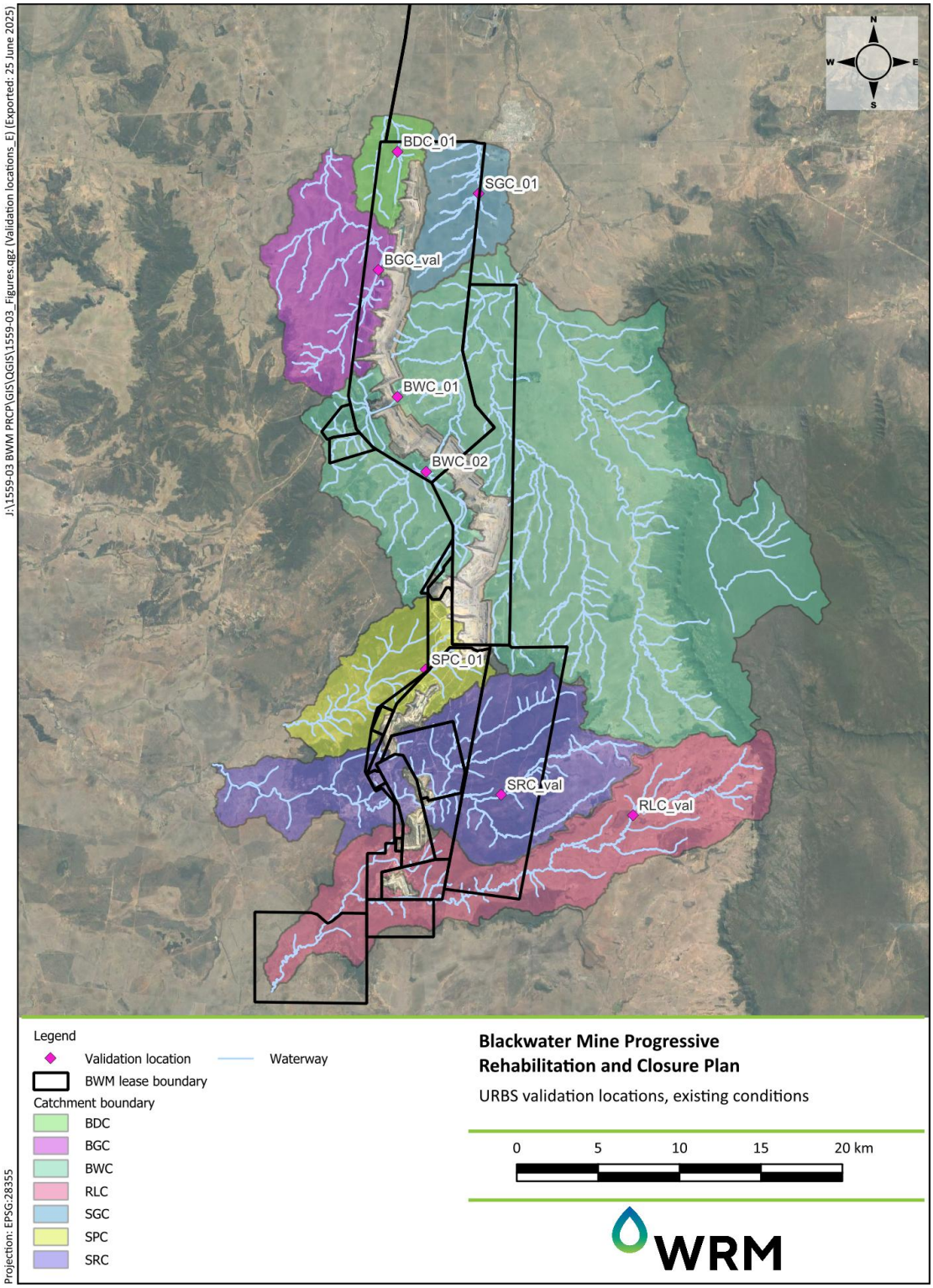


Figure 6.1 URBS validation locations

6.3 ADJUSTMENT FOR CLIMATE CHANGE

Based on the latest guidance on climate change provided in ARR 2019 v4.2, global temperatures have already risen since the baseline historical rainfall data midpoint of 1961-1990. Therefore, to assess current (2025) flood risks, design rainfall estimates require factoring up to account for this temperature increase that has already occurred.

Design Intensity-Frequency-Duration (IFD) design rainfall intensities were scaled up using uplift factors obtained from ARR datahub[1], corresponding to the SSP5-8.5 (year 2030) climate scenario. The associated pre-burst rainfalls were also scaled up accordingly.

The SSP5-8.5 climate adjustments account for approximately 1.3°C of global warming up to 2025 since the historical baseline period of 1961-1990. Table 6.2 shows the corresponding 1% AEP design rainfall uplift factors for various storm durations (as percentage increases compared to the baseline).

Table 6.2 Adopted design rainfall uplift factors (SSP5-8.5 year 2030)

Storm duration	Rainfall uplift factor
<1 hour	20%
1.5 Hours	18%
2 Hours	17%
3 Hours	16%
4.5 Hours	14%
6 Hours	13%
9 Hours	13%
12 Hours	12%
18 Hours	11%
>24 Hours	11%

6.4 MODEL VALIDATION RESULTS

Table 6.3 compares the URBS peak discharges for the 1% AEP design events against discharges estimated using the Rational Method, QRT and RFFE methods. For the RFFE, design peak discharges were estimated using both the 2016 and 2021 versions of the RFFE.

The validation results show that the URBS model predicted design peak discharges generally correspond well (within 20%) to the Rational Method and QRT design peak discharge estimates. However, the differences between URBS and RFFE peak discharges are greater.

There is considerable uncertainty in the RFFE design peak discharges, which are reliant upon the accuracy of Flood Frequency Analysis results from nearby gauged catchments. However, the URBS model predicted design peak discharges are generally within the range of uncertainty (i.e. 5th to 95th percentile) of the RFFE peak discharge estimates.

[1] https://data.arr-software.org/

Table 6.3 Model validation results for the 1% AEP event

Location (Figure 6.1)	1% AEP design peak discharge (m^3/s)					
	URBS	QRT	Rational Method	RFFE		
				Flow	5%ile	95%ile
BDC	78	77	73	316	83	1,102
BGC	259	203	222	493	144	1,550
BWC_L1	172	174	191	520	140	1,796
BWC_L2	190	189	176	471	130	1,596
RLC	110	176	119	785	212	2,758
SGC	147	182	170	535	141	1,868
SPC	117	116	133	583	155	2,049
SRC	203	190	168	1,084	304	3,672

7 REFERENCES

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GHD, 2021	GHD Pty Ltd, June 2021, *Blackwater Mine Flood Study*
PPK, 1994	PPK Consultants Pty Ltd, March 1994, *Rockland Creek Diversion Construction Report*
SLR, 2024a	SLR Consulting Australia Pty Ltd, 10 October 2024, *Blackwater Mine Progressive Rehabilitation and Closure Plan – Voids in Floodplain Modelling*
SLR, 2024b	SLR Consulting Australia Pty Ltd, 10 October 2024, *Blackwater Mine Progressive Rehabilitation and Closure Plan – Rehabilitation Flood Assessments*
WRM, 2025a	WRM Water & Environment Pty Ltd, November 2025, *Blackwater Mine Progressive Rehabilitation and Closure Plan – Void in Floodplain Modelling*
WRM, 2025b	WRM Water & Environment Pty Ltd, November 2025, *Blackwater Mine Progressive Rehabilitation and Closure Plan – Final Landform Flood Modelling*

APPENDIX A URBS MODEL CONFIGURATION

A.1 BDC CATCHMENT

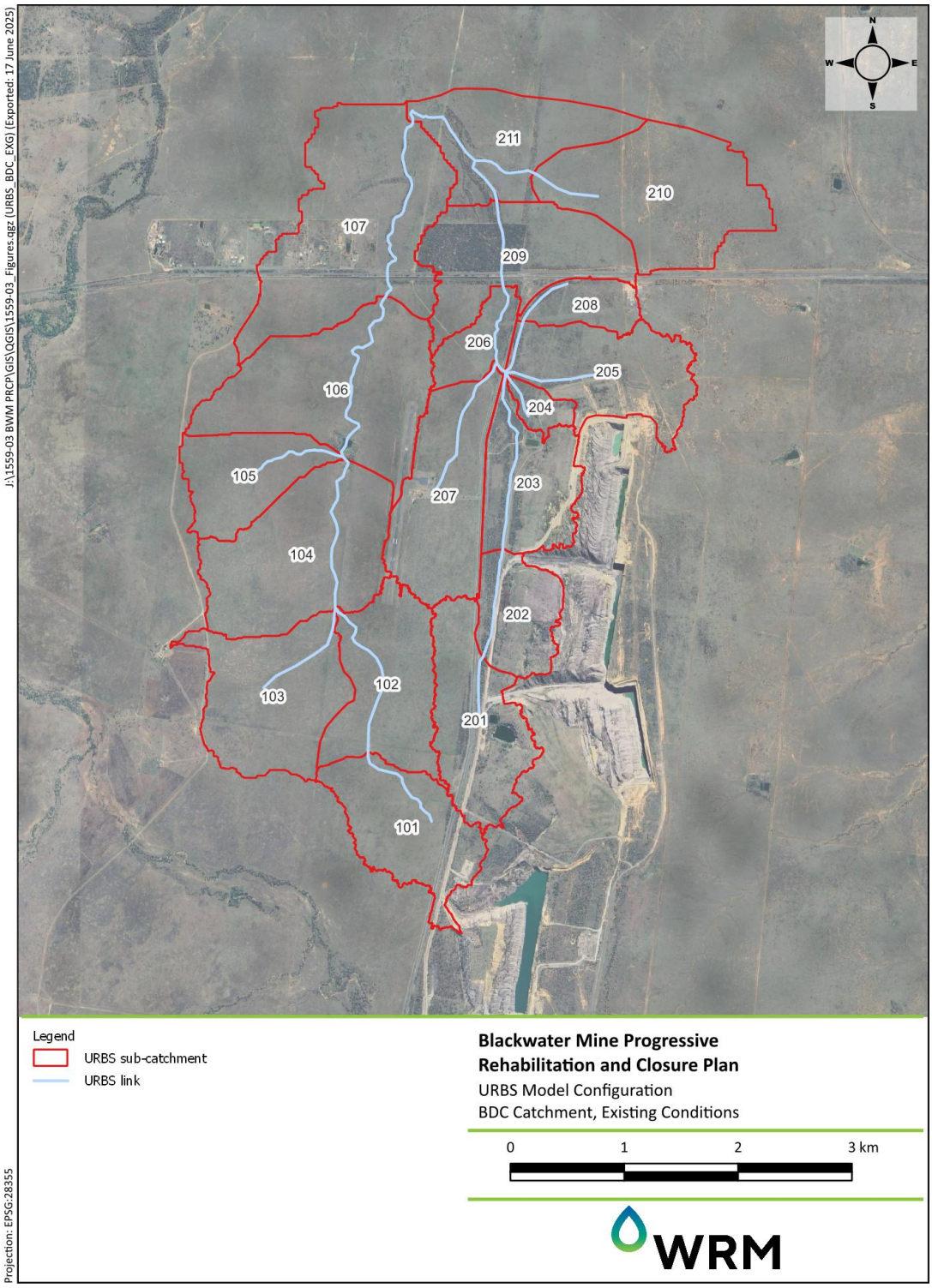


Figure A.1 URBS model configuration of the BDC catchment

Table A.1 URBS catchment parameters of the BDC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.15	0	0.07	0.007
102	1.26	0	0.07	0.006
103	1.46	0	0.07	0.010
104	1.83	0	0.07	0.007
105	0.83	0	0.07	0.011
106	2.02	0	0.07	0.005
107	2.46	0	0.07	0.007
201	1.20	0	0.07	0.009
202	0.68	0	0.07	0.015
203	0.95	0	0.07	0.009
204	0.17	0	0.07	0.012
205	1.16	0	0.07	0.006
206	0.39	0	0.07	0.005
207	1.36	0	0.07	0.007
208	0.38	0	0.07	0.006
209	1.39	0	0.07	0.007
210	1.72	0	0.07	0.006
211	1.19	0	0.07	0.005

A.2 SGC CATCHMENT

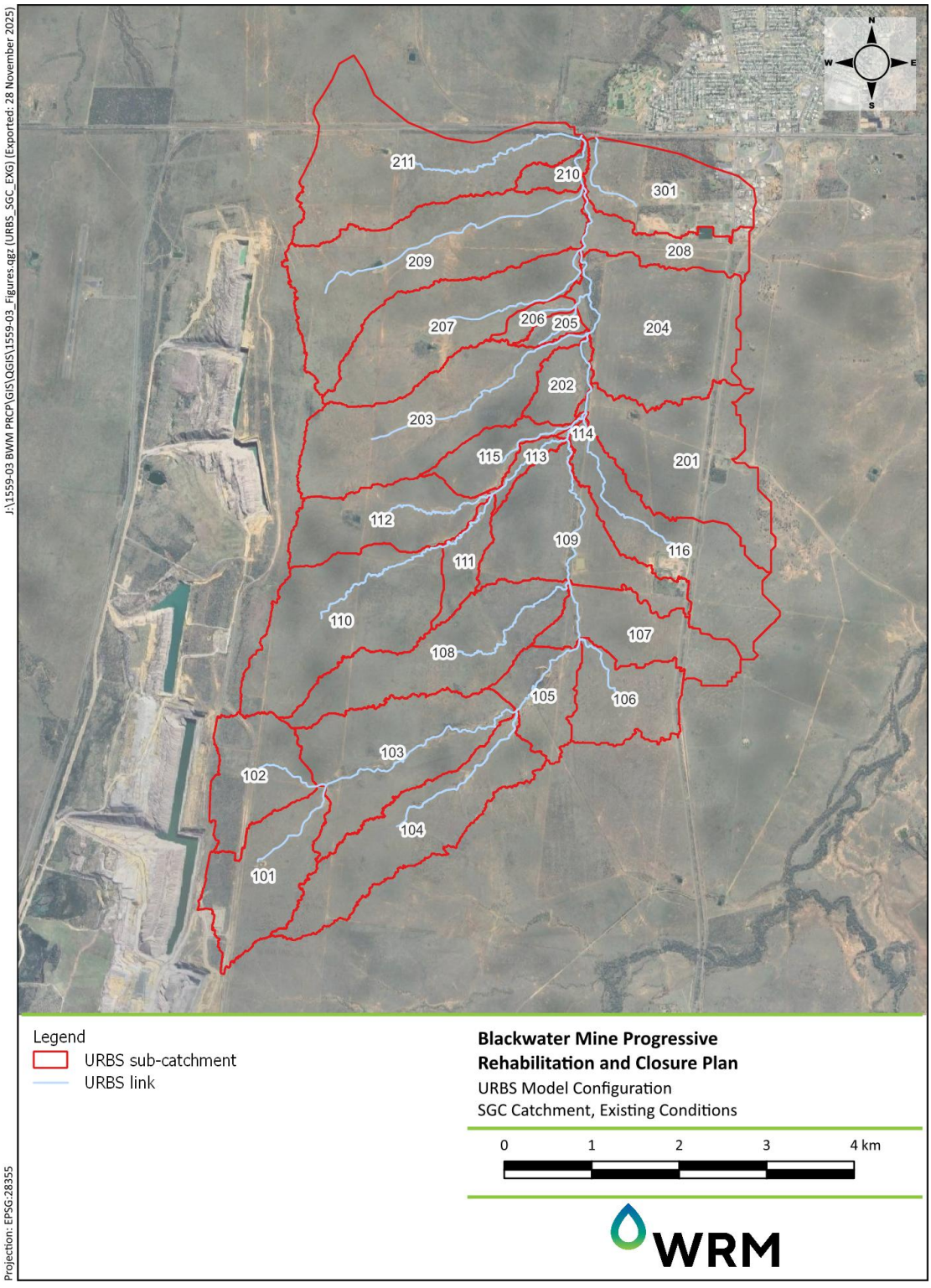


Figure A.2 URBS model configuration of the SGC catchment

Table A.2 URBS catchment parameters of the SGC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.58	0	0.07	0.009
102	1.29	0	0.07	0.008
103	2.37	0	0.07	0.007
104	2.19	0	0.07	0.007
105	0.87	0	0.07	0.007
106	1.14	0	0.07	0.008
107	1.37	0	0.07	0.009
108	2.2	0	0.07	0.008
109	2.02	0	0.07	0.007
110	2.69	0	0.07	0.008
111	0.46	0	0.07	0.009
112	1.46	0	0.07	0.009
113	0.19	0	0.07	0.007
114	0.02	0	0.07	0.005
115	0.63	0	0.07	0.007
116	2.12	0	0.07	0.007
201	2.44	0	0.07	0.01
202	0.51	0	0.07	0.004
203	2.72	0	0.07	0.007
204	2.69	0	0.07	0.01
205	0.17	0	0.07	0.007
206	0.2	0	0.07	0.007
207	2.22	0	0.07	0.008
208	0.81	0	0.07	0.008
209	3.34	0	0.07	0.007

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
210	0.27	0	0.07	0.003
211	3.14	0	0.07	0.005
301	1.58	0	0.07	0.008

A.3 BGC CATCHMENT

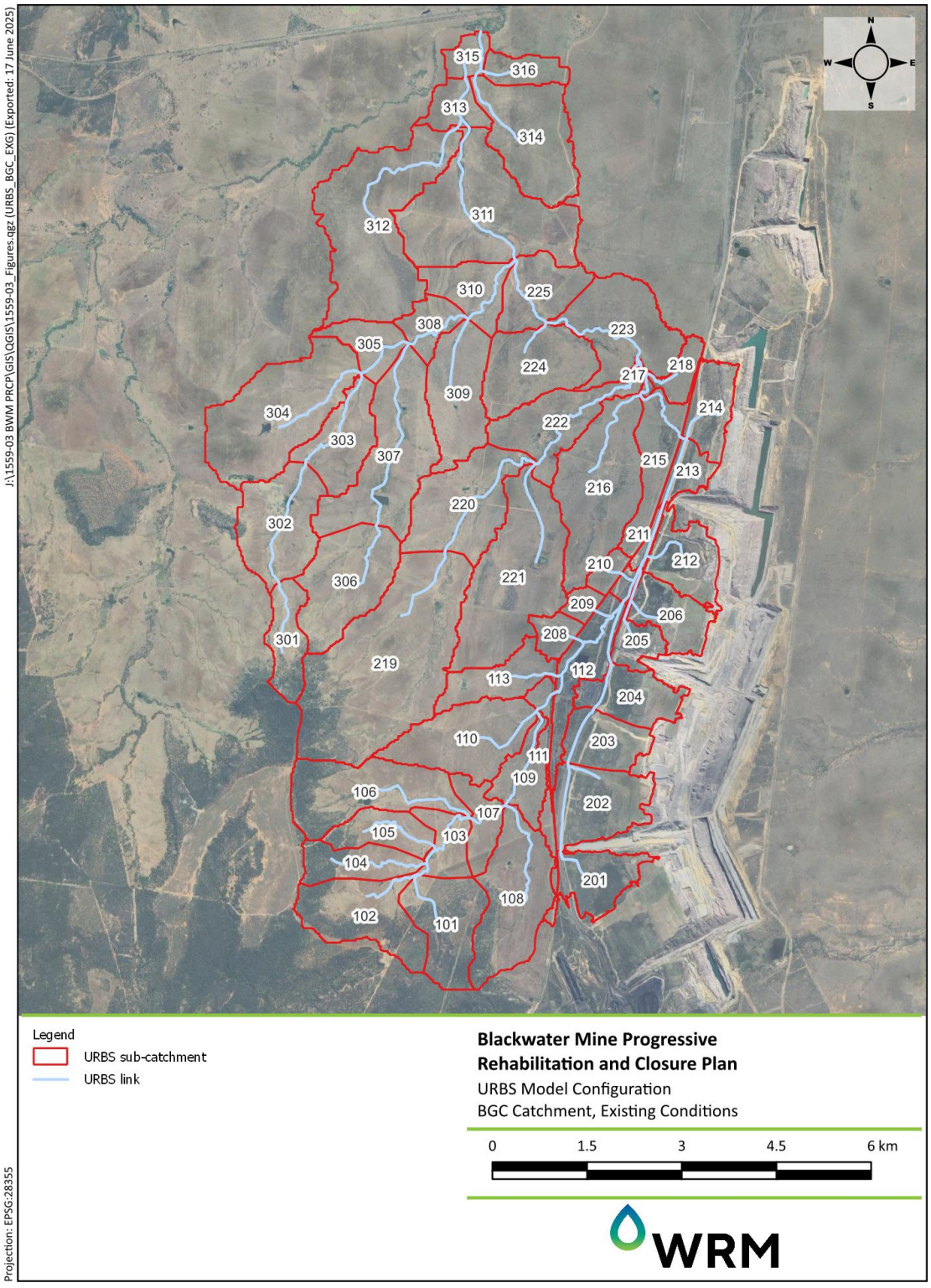


Figure A.3 URBS model configuration of the BGC catchment

Table A.3 URBS catchment parameters of the BGC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.66	0	0.035	0.017
102	1.90	0	0.035	0.019
103	0.72	0	0.035	0.007
104	0.96	0	0.035	0.010
105	0.89	0	0.035	0.009
106	2.25	0	0.035	0.023
107	0.72	0	0.035	0.007
108	2.37	0	0.035	0.024
109	0.87	0	0.035	0.009
110	2.07	0	0.035	0.021
111	0.54	0	0.035	0.005
112	1.22	0	0.035	0.012
113	1.04	0	0.035	0.010
201	1.10	0	0.035	0.011
202	1.63	0	0.035	0.016
203	1.06	0	0.035	0.011
204	1.14	0	0.035	0.011
205	0.55	0	0.035	0.006
206	1.03	0	0.035	0.010
207	0.15	0	0.035	0.002
208	0.41	0	0.035	0.004
209	0.25	0	0.035	0.003
210	0.27	0	0.035	0.003
211	0.17	0	0.035	0.002
212	1.16	0	0.035	0.012

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
213	0.50	0	0.035	0.005
214	0.93	0	0.035	0.009
215	1.26	0	0.035	0.013
216	2.89	0	0.035	0.029
217	0.06	0	0.035	0.001
218	0.42	0	0.035	0.004
219	5.72	0	0.035	0.057
220	2.24	0	0.035	0.022
221	3.52	0	0.035	0.035
222	1.69	0	0.035	0.017
223	2.17	0	0.035	0.022
224	1.87	0	0.035	0.019
225	1.26	0	0.035	0.013
301	0.93	0	0.035	0.009
302	2.00	0	0.035	0.020
303	1.33	0	0.035	0.013
304	3.27	0	0.035	0.033
305	0.76	0	0.035	0.008
306	2.17	0	0.035	0.022
307	2.89	0	0.035	0.029
308	0.63	0	0.035	0.006
309	1.81	0	0.035	0.018
310	1.00	0	0.035	0.010
311	3.79	0	0.035	0.038
312	4.12	0	0.035	0.041

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
313	0.61	0	0.035	0.006
314	2.26	0	0.035	0.023
315	0.40	0	0.035	0.010
316	0.58	0	0.035	0.010

A.4 BWC CATCHMENT

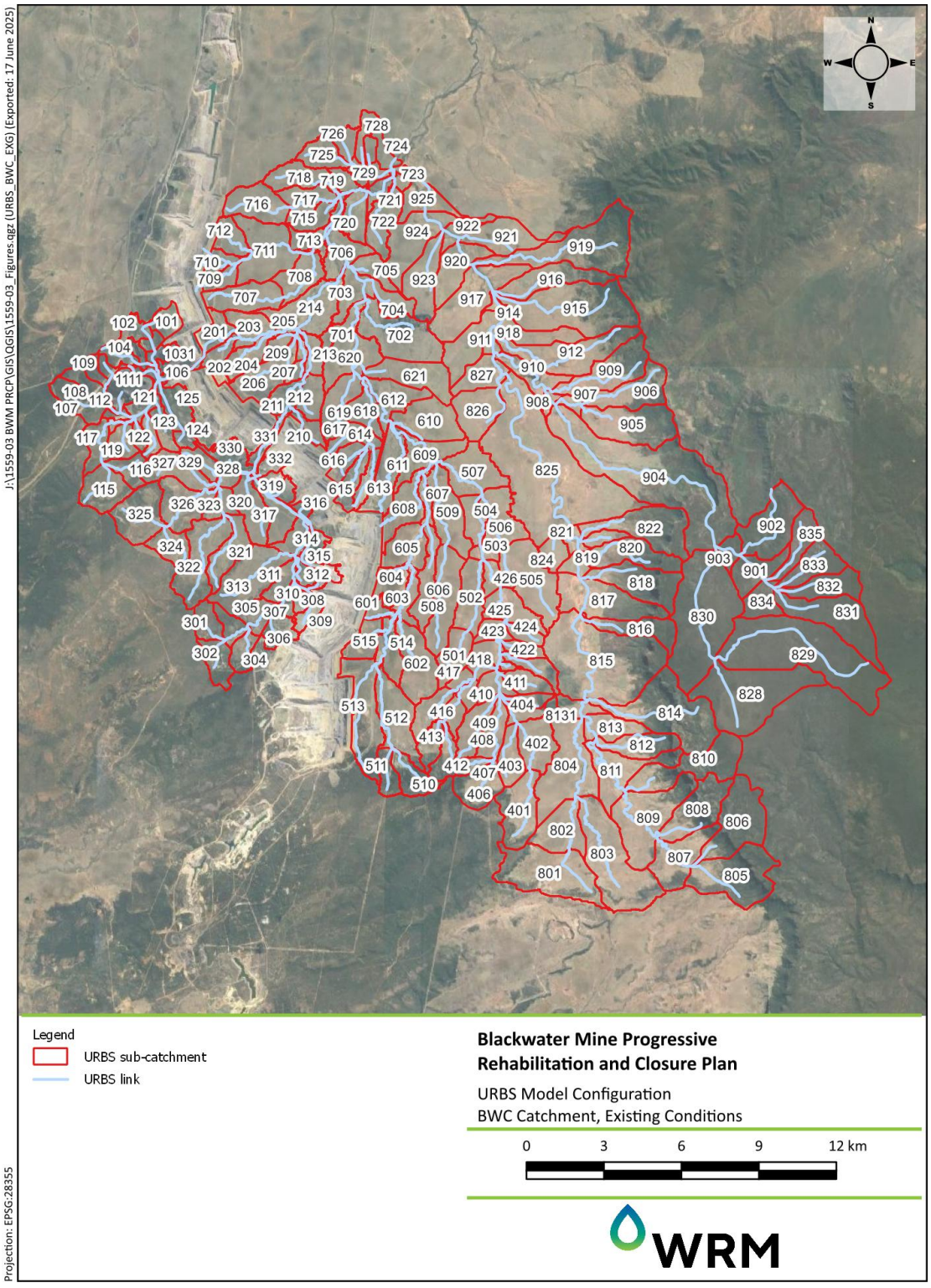


Figure A.4 URBS model configuration of the BWC catchment

Table A.4 URBS catchment parameters of the BWC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.11	0	0.07	0.019
102	0.88	0	0.07	0.009
103	0.47	0	0.07	0.022
104	0.97	0	0.07	0.028
105	0.51	0	0.07	0.021
106	0.37	0	0.07	0.004
107	2.02	0	0.07	0.030
108	1.10	0	0.04	0.070
109	0.65	0	0.07	0.028
110	0.42	0	0.07	0.044
111	0.02	0	0.07	0.006
112	0.10	0	0.07	0.009
113	1.94	0	0.07	0.005
114	0.33	0	0.07	0.020
115	2.55	0	0.07	0.017
116	1.21	0	0.07	0.015
117	1.61	0	0.07	0.012
118	0.28	0	0.07	0.010
119	1.14	0	0.07	0.036
120	0.50	0	0.07	0.029
121	0.95	0	0.07	0.009
122	0.79	0	0.07	0.023
123	1.05	0	0.07	0.018
124	0.60	0	0.07	0.027
125	1.72	0	0.07	0.013

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
201	1.45	0	0.07	0.006
202	1.26	0	0.07	0.012
203	1.77	0	0.07	0.007
204	1.65	0	0.07	0.008
205	0.32	0	0.07	0.002
206	2.94	0	0.07	0.008
207	0.46	0	0.07	0.007
208	0.39	0	0.07	0.003
209	0.67	0	0.07	0.008
210	0.83	0	0.07	0.010
211	1.36	0	0.07	0.006
212	1.54	0	0.07	0.011
213	1.04	0	0.07	0.004
214	3.78	0	0.07	0.004
301	1.34	0	0.07	0.033
302	1.71	0	0.07	0.018
303	1.05	0	0.07	0.026
304	1.20	0	0.07	0.026
305	1.23	0	0.07	0.009
306	1.29	0	0.07	0.019
307	0.62	0	0.07	0.019
308	0.56	0	0.07	0.037
309	0.83	0	0.07	0.044
310	0.10	0	0.07	0.016
311	1.08	0	0.07	0.015

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
312	0.69	0	0.07	0.030
313	4.53	0	0.07	0.017
314	1.21	0	0.07	0.004
315	1.44	0	0.07	0.007
316	0.39	0	0.07	0.074
317	1.80	0	0.07	0.009
318	0.78	0	0.07	0.053
319	0.35	0	0.07	0.085
320	2.47	0	0.07	0.013
321	2.35	0	0.07	0.017
322	4.18	0	0.07	0.016
323	1.05	0	0.07	0.013
324	1.70	0	0.07	0.019
325	3.44	0	0.07	0.023
326	3.05	0	0.07	0.013
327	2.58	0	0.07	0.013
328	0.66	0	0.07	0.004
329	1.04	0	0.07	0.015
330	1.44	0	0.07	0.018
331	0.80	0	0.07	0.006
332	0.57	0	0.07	0.029
401	3.50	0	0.07	0.015
402	2.59	0	0.07	0.011
403	1.73	0	0.07	0.012
404	0.92	0	0.07	0.017

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
405	0.74	0	0.07	0.032
406	2.38	0	0.07	0.018
407	0.62	0	0.07	0.027
408	1.72	0	0.07	0.012
409	2.13	0	0.07	0.015
410	1.21	0	0.07	0.007
411	1.35	0	0.07	0.030
412	1.33	0	0.07	0.022
413	1.28	0	0.07	0.024
414	0.97	0	0.07	0.016
415	0.66	0	0.07	0.015
416	1.65	0	0.07	0.013
417	0.55	0	0.07	0.011
418	0.57	0	0.07	0.011
419	0.21	0	0.07	0.018
420	1.00	0	0.07	0.015
421	1.25	0	0.07	0.026
422	0.87	0	0.07	0.015
423	1.00	0	0.07	0.008
424	0.79	0	0.07	0.016
425	2.31	0	0.07	0.009
426	1.00	0	0.07	0.005
501	2.03	0	0.07	0.010
502	2.62	0	0.07	0.006
503	0.56	0	0.07	0.005

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
504	1.46	0	0.07	0.005
505	4.78	0	0.07	0.007
506	2.93	0	0.07	0.006
507	3.35	0	0.07	0.004
508	3.88	0	0.07	0.006
509	3.46	0	0.07	0.006
510	1.80	0	0.07	0.032
511	1.23	0	0.07	0.031
512	3.76	0	0.07	0.015
513	4.77	0	0.07	0.013
514	1.85	0	0.07	0.007
515	1.57	0	0.07	0.012
601	0.63	0	0.07	0.012
602	3.63	0	0.07	0.008
603	1.13	0	0.07	0.005
604	1.69	0	0.07	0.011
605	2.43	0	0.07	0.006
606	2.29	0	0.07	0.007
607	0.69	0	0.07	0.004
608	2.44	0	0.07	0.005
609	2.66	0	0.07	0.006
610	3.38	0	0.07	0.006
611	2.97	0	0.07	0.007
612	2.44	0	0.07	0.006
613	1.09	0	0.07	0.009

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
614	0.38	0	0.07	0.006
615	1.36	0	0.07	0.007
616	1.19	0	0.07	0.010
617	1.02	0	0.07	0.013
618	1.58	0	0.07	0.003
619	2.57	0	0.07	0.009
620	3.14	0	0.07	0.008
621	3.18	0	0.07	0.009
701	1.23	0	0.07	0.005
702	4.86	0	0.07	0.007
703	1.79	0	0.07	0.005
704	1.35	0	0.07	0.006
705	1.22	0	0.07	0.012
706	2.13	0	0.07	0.005
707	2.90	0	0.07	0.008
708	2.27	0	0.07	0.007
709	0.93	0	0.07	0.010
710	0.89	0	0.07	0.012
711	4.49	0	0.07	0.008
712	1.47	0	0.07	0.012
713	1.27	0	0.07	0.004
714	0.55	0	0.07	0.002
715	1.15	0	0.07	0.006
716	2.84	0	0.07	0.011
717	1.89	0	0.07	0.009

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
718	2.25	0	0.07	0.008
719	0.73	0	0.07	0.007
720	1.69	0	0.07	0.005
721	0.77	0	0.07	0.004
722	2.29	0	0.07	0.009
723	0.36	0	0.07	0.002
724	0.88	0	0.07	0.008
725	1.67	0	0.07	0.007
726	1.07	0	0.07	0.007
727	0.61	0	0.07	0.008
728	0.92	0	0.07	0.012
729	0.52	0	0.07	0.004
730	0.46	0	0.07	0.012
801	6.29	0	0.07	0.011
802	3.02	0	0.07	0.013
803	7.28	0	0.07	0.009
804	6.31	0	0.07	0.009
805	5.39	0	0.07	0.075
806	4.86	0	0.07	0.108
807	3.45	0	0.07	0.040
808	3.68	0	0.07	0.107
809	5.80	0	0.07	0.044
810	4.62	0	0.07	0.106
811	3.55	0	0.07	0.008
812	2.30	0	0.07	0.059

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
813	1.92	0	0.07	0.021
814	7.10	0	0.07	0.074
815	11.57	0	0.07	0.015
816	2.31	0	0.07	0.104
817	4.75	0	0.07	0.072
818	3.83	0	0.07	0.076
819	0.74	0	0.07	0.010
820	3.15	0	0.07	0.039
821	0.75	0	0.07	0.005
822	4.47	0	0.07	0.062
824	1.24	0	0.07	0.010
825	17.80	0	0.07	0.004
826	2.94	0	0.07	0.014
827	2.01	0	0.07	0.008
828	8.08	0	0.07	0.019
829	12.06	0	0.07	0.015
830	10.24	0	0.07	0.009
831	4.87	0	0.07	0.030
832	2.36	0	0.07	0.039
833	2.38	0	0.07	0.070
834	1.62	0	0.07	0.034
835	2.01	0	0.07	0.045
901	2.16	0	0.07	0.037
902	4.27	0	0.07	0.034
903	0.86	0	0.07	0.031

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
904	15.68	0	0.07	0.028
905	4.65	0	0.07	0.041
906	3.15	0	0.07	0.034
907	0.56	0	0.07	0.006
908	0.42	0	0.07	0.010
909	3.92	0	0.07	0.027
910	2.02	0	0.07	0.005
911	0.34	0	0.07	0.005
912	4.87	0	0.07	0.022
914	0.39	0	0.07	0.004
915	8.00	0	0.07	0.022
916	3.12	0	0.07	0.022
917	5.05	0	0.07	0.006
918	5.11	0	0.07	0.005
919	7.07	0	0.07	0.030
920	2.75	0	0.07	0.007
921	3.07	0	0.07	0.011
922	0.80	0	0.07	0.002
923	3.09	0	0.07	0.007
924	4.33	0	0.07	0.005
925	2.19	0	0.07	0.002
1031	0.72	0	0.07	0.012
1111	0.44	0	0.07	0.021
3091	0.20	0	0.07	0.036
8131	1.06	0	0.07	0.021

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
8211	0.76	0	0.07	0.026

A.5 SPC CATCHMENT

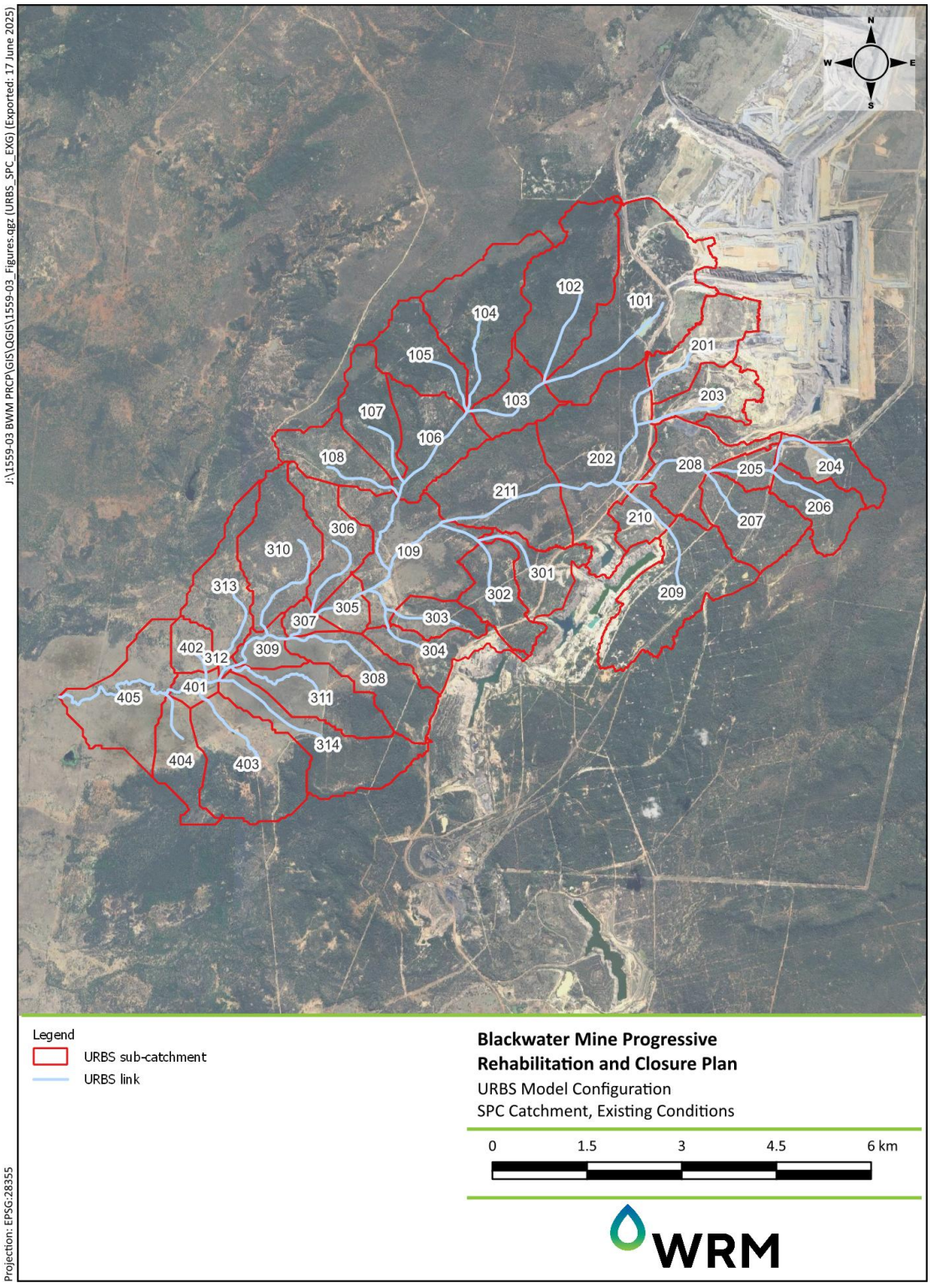


Figure A.5 URBS model configuration of the SPC catchment

Table A.5 URBS catchment parameters of the SPC catchment model

ID	Total Area (km2)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	4.00	0	0.07	0.012
102	2.89	0	0.07	0.018
103	1.00	0	0.07	0.016
104	2.70	0	0.07	0.016
105	1.47	0	0.07	0.028
106	1.69	0	0.07	0.017
107	1.31	0	0.07	0.027
108	1.27	0	0.07	0.027
109	2.90	0	0.07	0.009
201	1.45	0	0.07	0.019
202	3.63	0	0.07	0.007
203	1.05	0	0.07	0.025
204	0.98	0	0.07	0.032
205	0.45	0	0.07	0.029
206	1.07	0	0.07	0.032
207	1.60	0	0.07	0.029
208	1.55	0	0.07	0.011
209	2.80	0	0.07	0.038
210	0.66	0	0.07	0.027
211	2.77	0	0.07	0.011
301	1.06	0	0.07	0.017
302	1.30	0	0.07	0.022
303	0.69	0	0.07	0.024
304	1.12	0	0.07	0.022
305	0.49	0	0.07	0.009

ID	Total Area (km2)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
306	1.32	0	0.07	0.010
307	0.31	0	0.07	0.009
308	1.77	0	0.07	0.019
309	0.53	0	0.07	0.005
310	2.18	0	0.07	0.017
311	1.56	0	0.07	0.015
312	0.07	0	0.07	0.006
313	1.57	0	0.07	0.013
314	2.15	0	0.07	0.012
401	0.33	0	0.07	0.014
402	0.52	0	0.07	0.024
403	2.73	0	0.07	0.019
404	1.13	0	0.07	0.025
405	2.24	0	0.07	0.007

A.6 SRC CATCHMENT

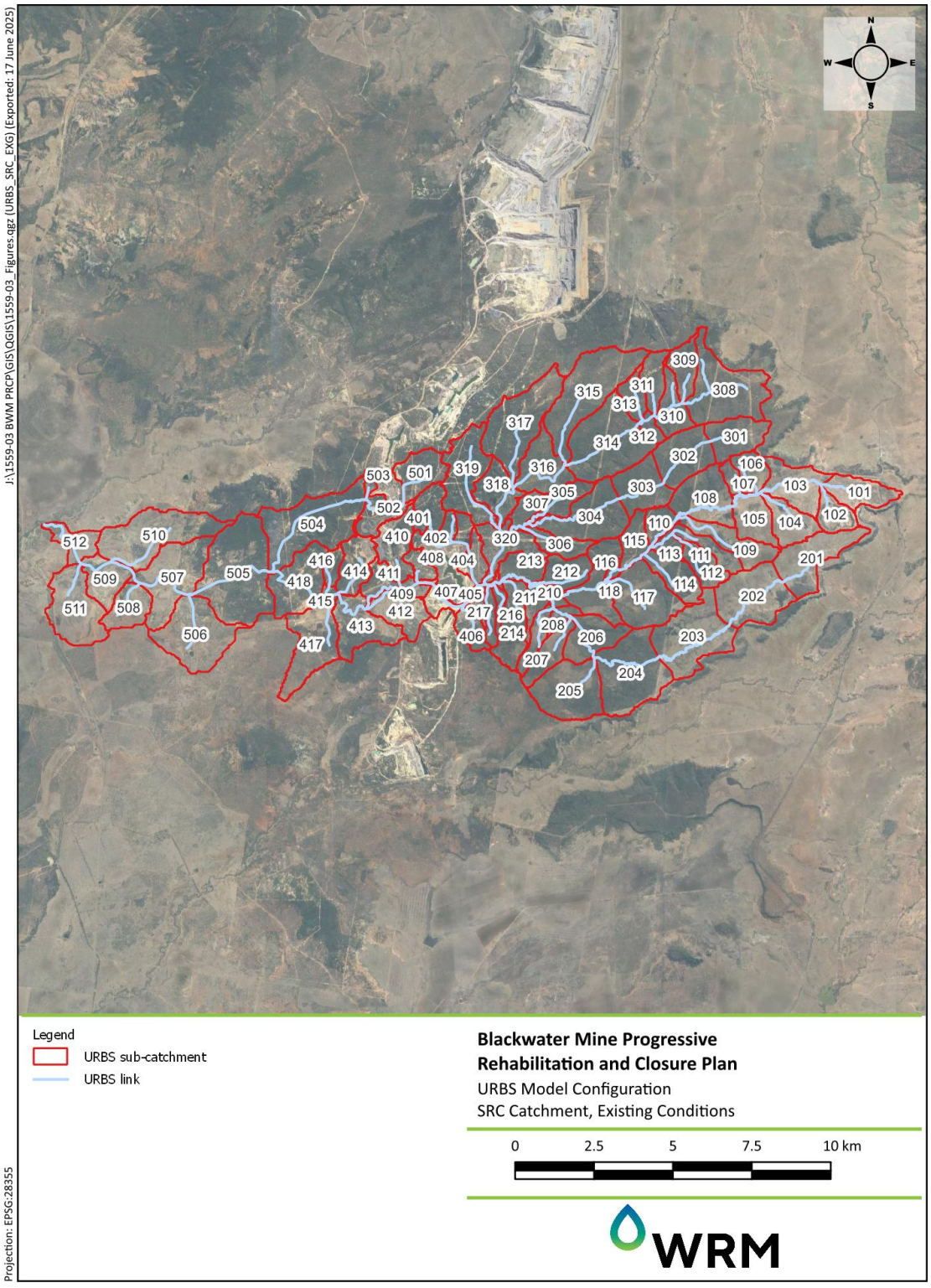


Figure A.6 URBS model configuration of the SRC catchment

Table A.6 URBS catchment parameters of the SRC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.70	0	0.045	0.016
102	1.18	0	0.045	0.016
103	2.37	0	0.045	0.016
104	1.66	0	0.045	0.024
105	1.75	0	0.045	0.027
106	1.13	0	0.045	0.039
107	0.48	0	0.045	0.048
108	2.73	0	0.045	0.019
109	1.92	0	0.045	0.017
110	0.88	0	0.045	0.010
111	1.09	0	0.045	0.022
112	1.22	0	0.045	0.030
113	0.56	0	0.045	0.013
114	1.67	0	0.045	0.025
115	1.17	0	0.045	0.009
116	0.22	0	0.045	0.015
117	3.37	0	0.045	0.025
118	2.75	0	0.045	0.013
201	2.99	0	0.045	0.015
202	3.56	0	0.045	0.010
203	4.26	0	0.045	0.016
204	4.50	0	0.045	0.017
205	3.45	0	0.045	0.022
206	2.04	0	0.045	0.017
207	1.33	0	0.045	0.028

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
208	0.50	0	0.045	0.028
209	0.97	0	0.045	0.031
210	0.21	0	0.045	0.014
211	0.93	0	0.045	0.016
212	1.40	0	0.045	0.020
213	1.11	0	0.045	0.016
214	2.08	0	0.045	0.026
215	0.13	0	0.045	0.005
216	0.40	0	0.045	0.042
217	0.58	0	0.045	0.044
301	2.00	0	0.045	0.015
302	2.56	0	0.045	0.014
303	2.28	0	0.045	0.031
304	3.32	0	0.045	0.011
305	1.21	0	0.045	0.013
306	1.09	0	0.045	0.022
307	0.88	0	0.045	0.015
308	4.36	0	0.045	0.012
309	1.31	0	0.045	0.028
310	1.47	0	0.045	0.024
311	1.18	0	0.045	0.032
312	0.45	0	0.045	0.053
313	0.99	0	0.045	0.033
314	4.85	0	0.045	0.014
315	4.84	0	0.045	0.019

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
316	2.33	0	0.045	0.021
317	4.29	0	0.045	0.018
318	1.76	0	0.045	0.012
319	3.29	0	0.045	0.016
320	1.98	0	0.045	0.008
401	1.30	0	0.045	0.039
402	0.52	0	0.045	0.022
403	0.50	0	0.045	0.023
404	0.91	0	0.045	0.004
405	0.46	0	0.045	0.015
406	1.07	0	0.045	0.044
407	0.73	0	0.045	0.010
408	0.63	0	0.045	0.007
409	0.43	0	0.045	0.017
410	1.99	0	0.045	0.018
411	0.90	0	0.045	0.011
412	1.82	0	0.045	0.010
413	2.61	0	0.045	0.005
414	1.77	0	0.045	0.016
415	0.22	0	0.045	0.032
416	0.59	0	0.045	0.037
417	3.27	0	0.045	0.020
418	2.92	0	0.045	0.021
501	1.80	0	0.045	0.015
502	1.17	0	0.045	0.019

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
503	0.23	0	0.045	0.032
504	5.17	0	0.045	0.012
505	6.15	0	0.045	0.006
506	4.05	0	0.045	0.017
507	3.90	0	0.045	0.007
508	1.60	0	0.045	0.034
509	1.75	0	0.045	0.019
510	4.43	0	0.045	0.008
511	3.38	0	0.045	0.015
512	1.25	0	0.045	0.003

A.7 RLC CATCHMENT

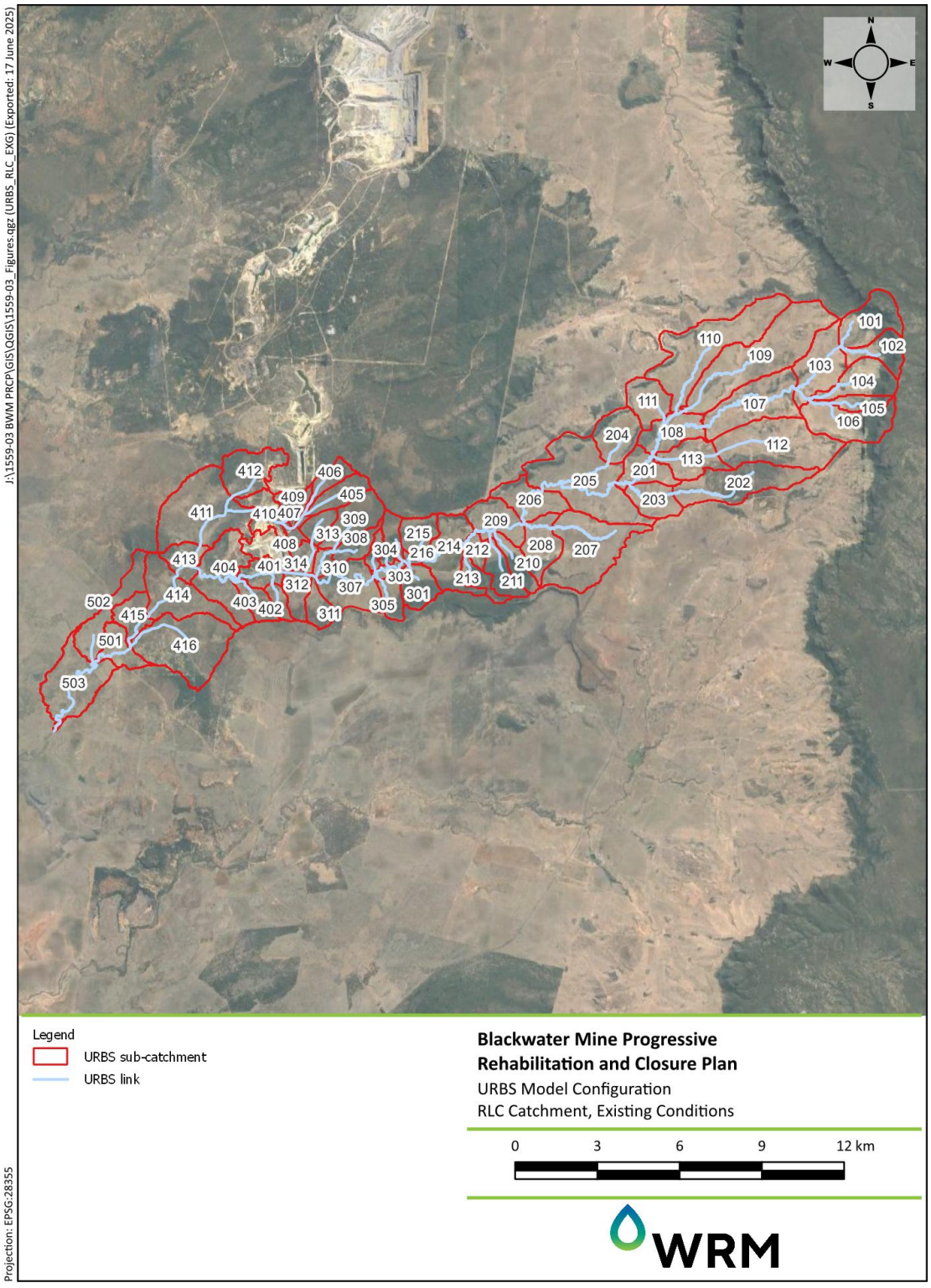


Figure A.7 URBS model configuration of the RLC catchment

Table A.7 URBS catchment parameters of the RLC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	8.50	0	0.07	0.085
102	7.98	0	0.07	0.080
103	7.54	0	0.07	0.075
104	6.86	0	0.07	0.069
105	6.46	0	0.07	0.065
106	6.42	0	0.07	0.064
107	6.24	0	0.07	0.062
108	4.87	0	0.07	0.049
109	4.84	0	0.07	0.048
110	4.63	0	0.07	0.046
111	4.16	0	0.07	0.042
112	4.10	0	0.07	0.041
113	3.77	0	0.07	0.038
201	3.65	0	0.07	0.037
202	3.55	0	0.07	0.036
203	3.29	0	0.07	0.033
204	3.11	0	0.07	0.031
205	2.99	0	0.07	0.030
206	2.96	0	0.07	0.030
207	2.73	0	0.07	0.027
208	2.60	0	0.07	0.026
209	2.57	0	0.07	0.026
210	2.55	0	0.07	0.026
211	2.49	0	0.07	0.025
212	2.48	0	0.07	0.025

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
213	2.46	0	0.07	0.025
214	2.46	0	0.07	0.025
215	2.19	0	0.07	0.022
216	2.00	0	0.07	0.020
301	1.99	0	0.07	0.020
302	1.89	0	0.07	0.019
303	1.82	0	0.07	0.018
304	1.79	0	0.07	0.018
305	1.69	0	0.07	0.017
306	1.67	0	0.07	0.017
307	1.66	0	0.07	0.017
308	1.61	0	0.07	0.016
309	1.56	0	0.07	0.016
310	1.56	0	0.07	0.016
311	1.46	0	0.07	0.015
312	1.37	0	0.07	0.014
313	1.31	0	0.07	0.013
314	1.29	0	0.07	0.013
401	1.29	0	0.07	0.013
402	1.24	0	0.07	0.012
403	1.23	0	0.07	0.012
404	1.16	0	0.07	0.012
405	1.16	0	0.07	0.012
406	1.12	0	0.07	0.011
407	1.07	0	0.07	0.011

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
408	1.05	0	0.07	0.011
409	1.00	0	0.07	0.010
410	0.76	0	0.07	0.008
411	0.75	0	0.07	0.008
412	0.75	0	0.07	0.008
413	0.66	0	0.07	0.007
414	0.60	0	0.07	0.006
415	0.51	0	0.07	0.005
416	0.49	0	0.07	0.005
501	0.29	0	0.07	0.003
502	0.23	0	0.07	0.002
503	0.14	0	0.07	0.001

APPENDIX B CALIBRATION EVENTS

B.1 2017 EVENT

B.1.1 Recorded rainfall

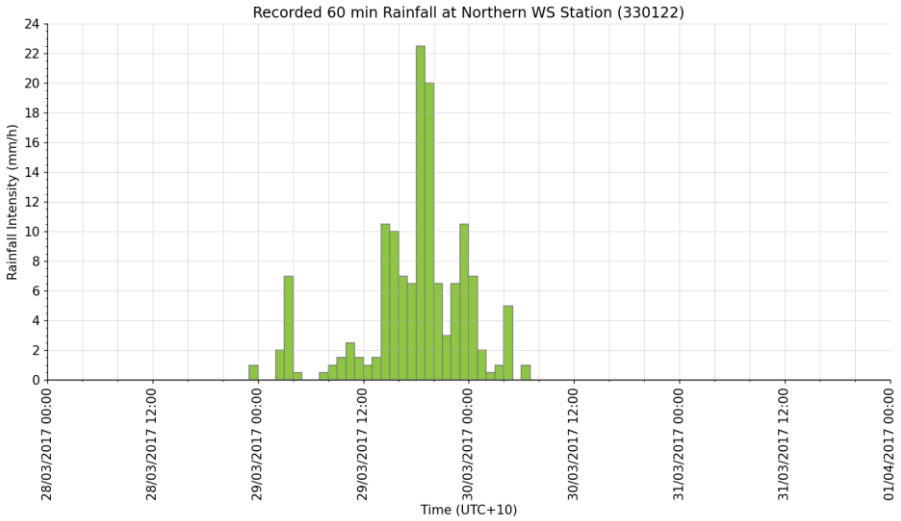


Figure B.1 Recorded rainfall at Northern WS Station (330122), 2017 event

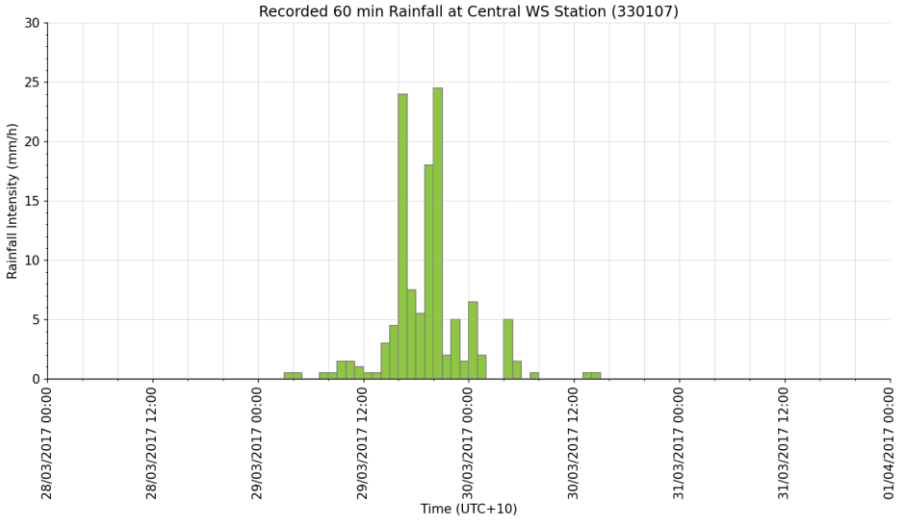


Figure B.2 Recorded rainfall at Central WS Station (330107), 2017 event

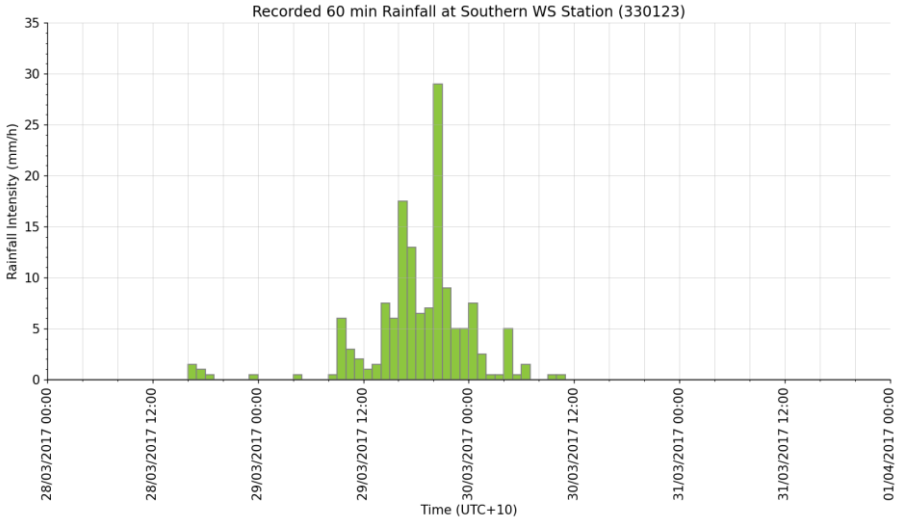


Figure B.3 Recorded rainfall at Southern WS Station (330123), 2017 event

B.1.2 Recorded water levels

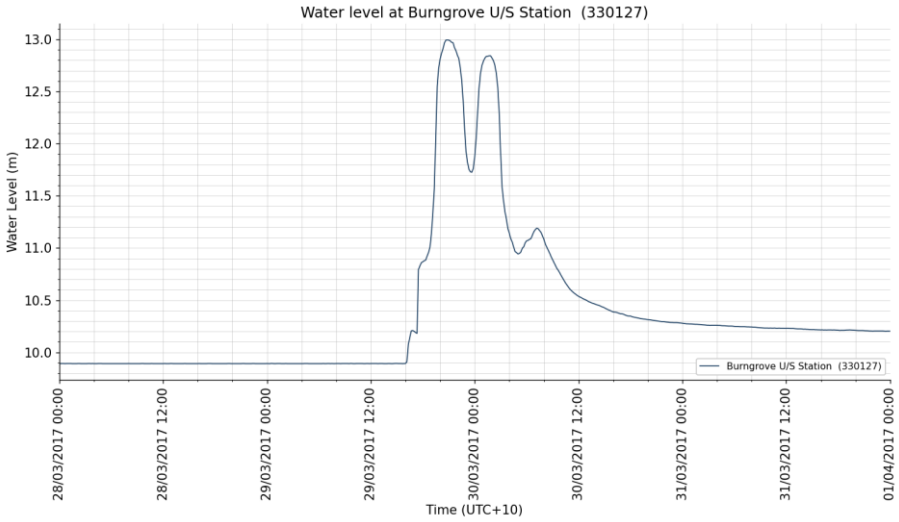


Figure B.4 Recorded water level at Burngrove D/S Station (330117), 2017 event

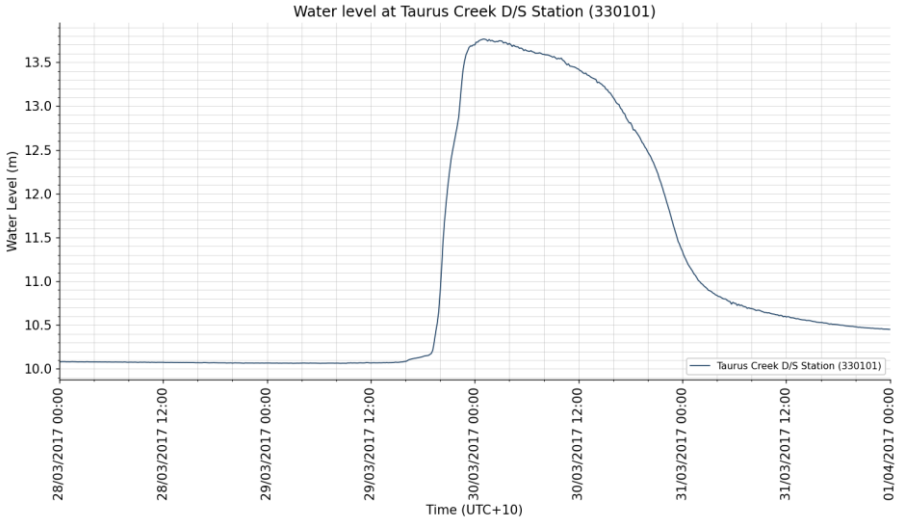


Figure B.5 Recorded water level at Taurus Creek D/S Station (330101), 2017 event

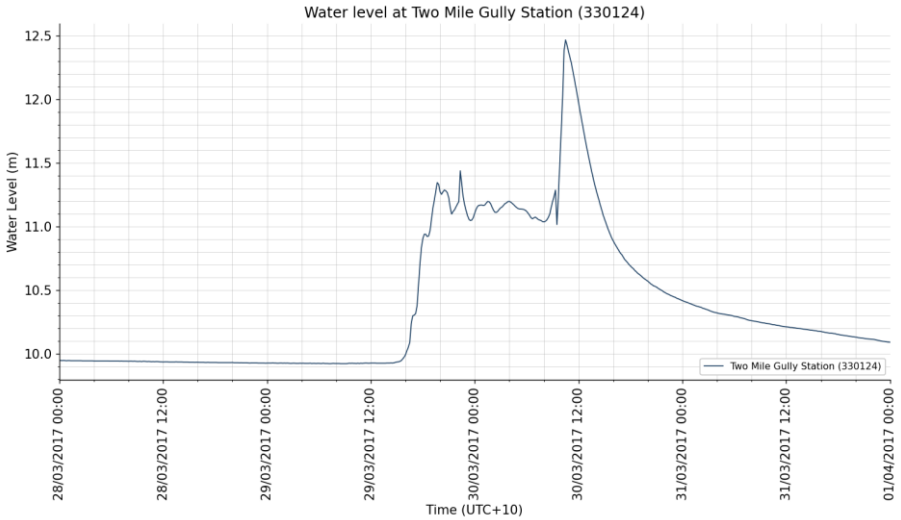


Figure B.6 Recorded water level at Two Mile Gully Station (330124), 2017 event

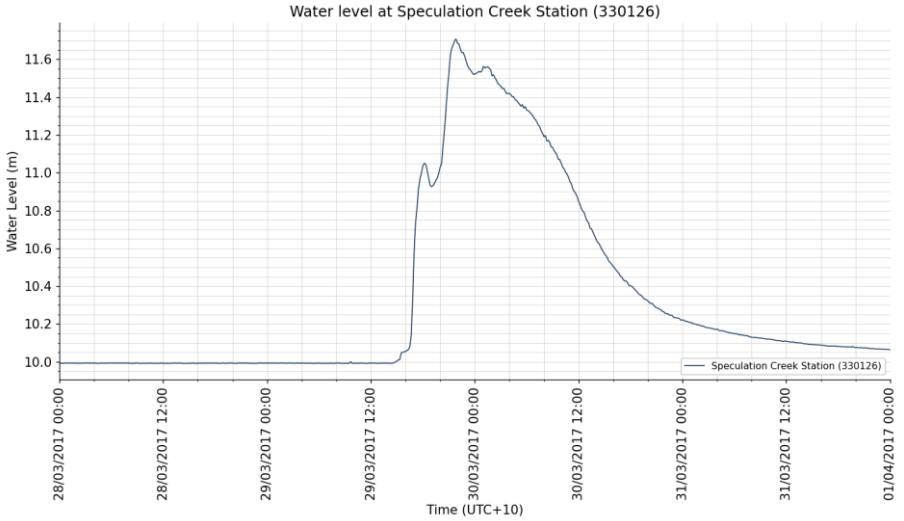


Figure B.7 Recorded water level at Speculation Creek Station (330126), 2017 event

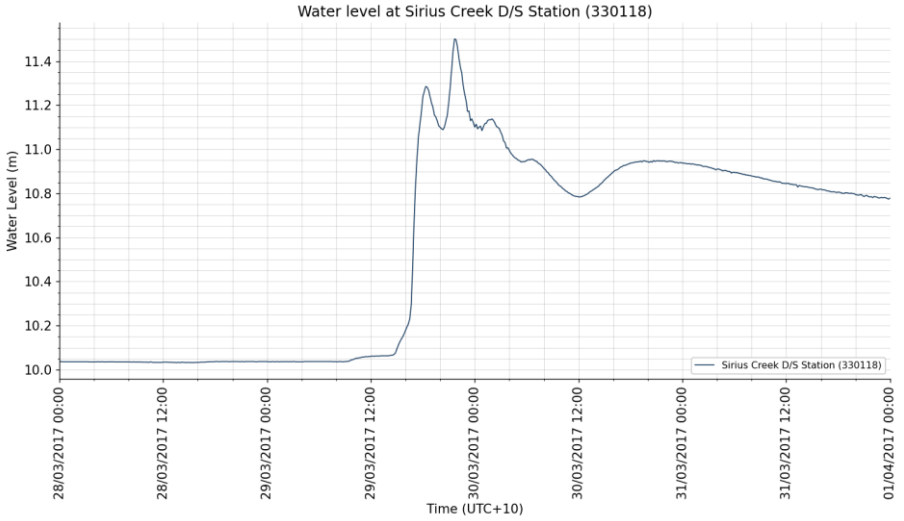


Figure B.8 Recorded water level at Sirius Creek Station (330118), 2017 event

B.2 2020 EVENT

B.2.1 Recorded rainfall

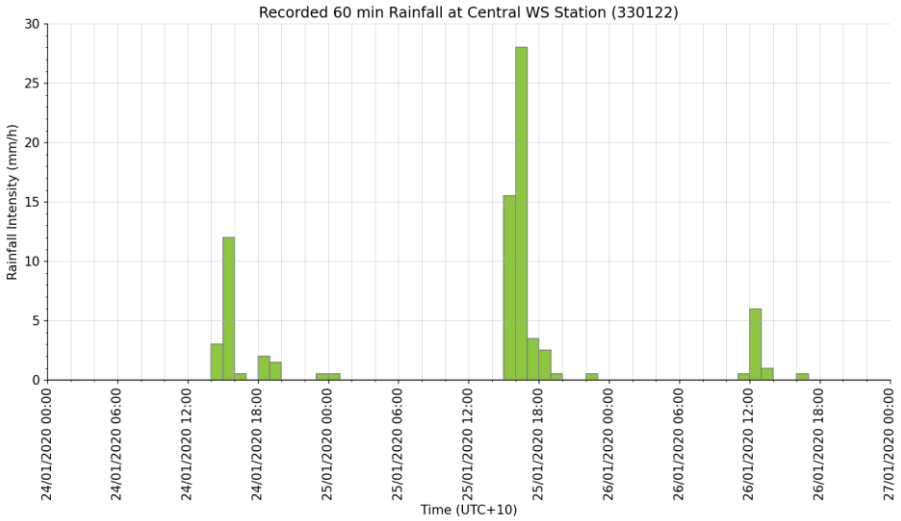


Figure B.9 Recorded rainfall at Northern WS Station (330122), 2020 event

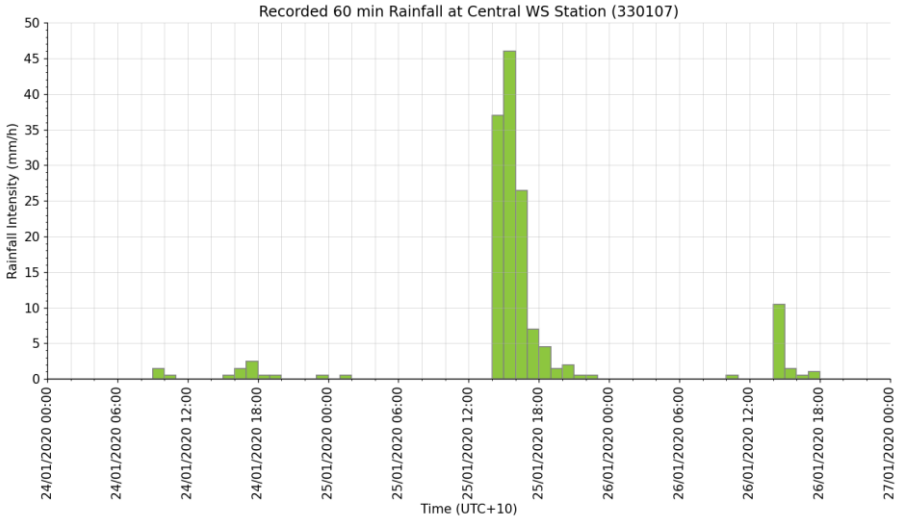


Figure B.10 Recorded rainfall at Central WS Station (330107), 2020 event

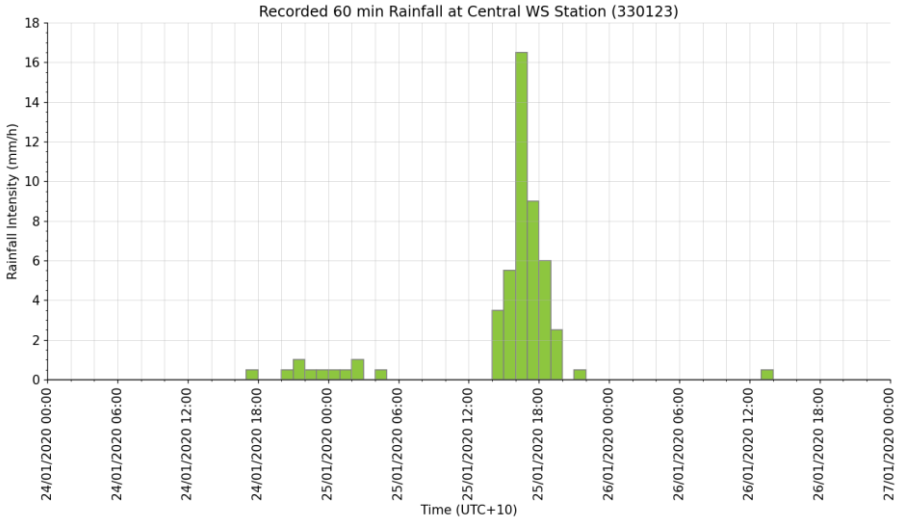


Figure B.11 **Recorded rainfall at Southern WS Station (330123), 2020 event**

B.2.2 Recorded water level

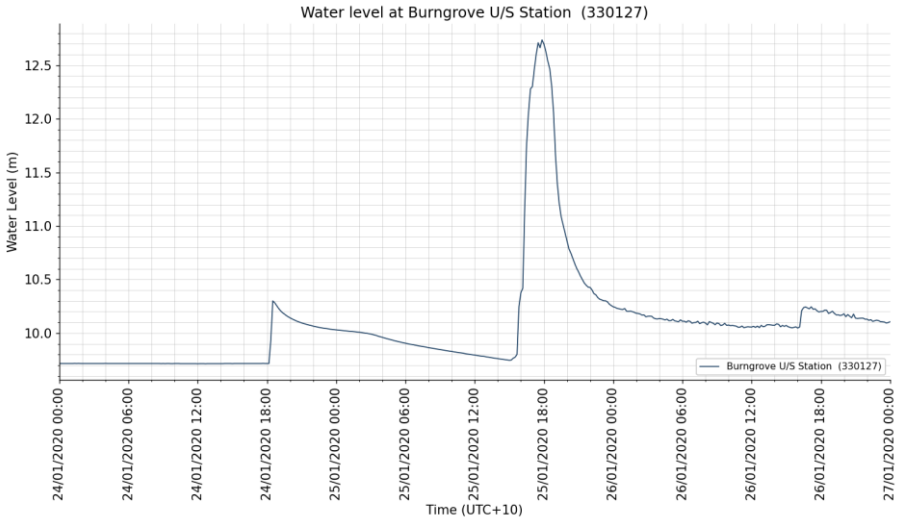


Figure B.12 **Recorded water level at Burngrove U/S Station (330127), 2020 event**

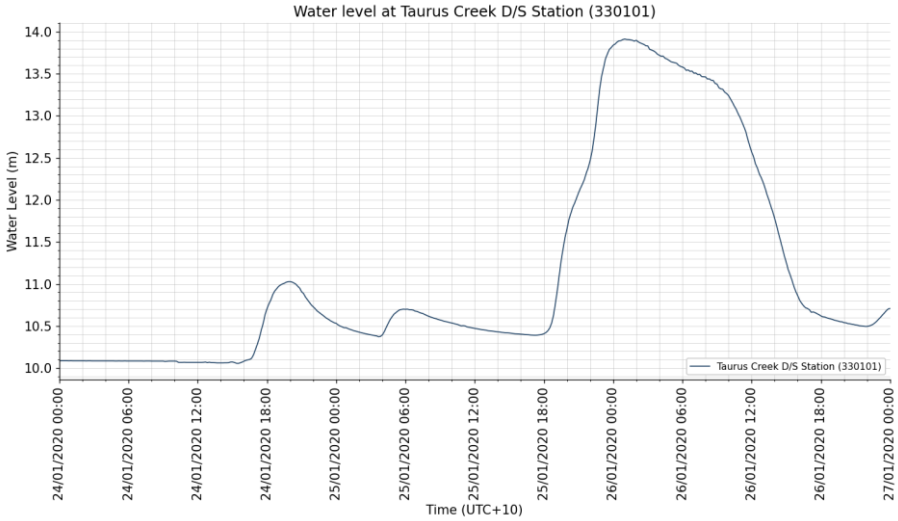


Figure B.13 **Recorded water level at Taurus Creek D/S Station (330101), 2020 event**

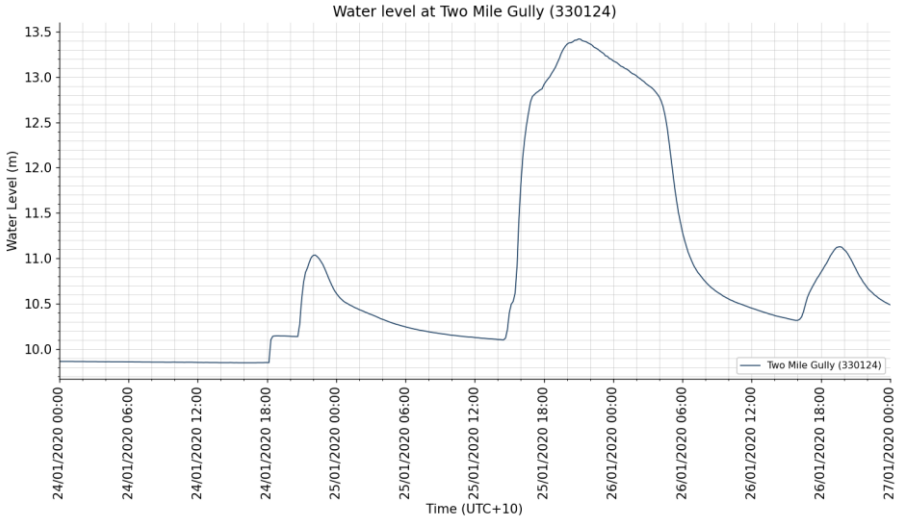


Figure B.14 **Recorded water level at Two Mile Gully Station (330124), 2020 event**

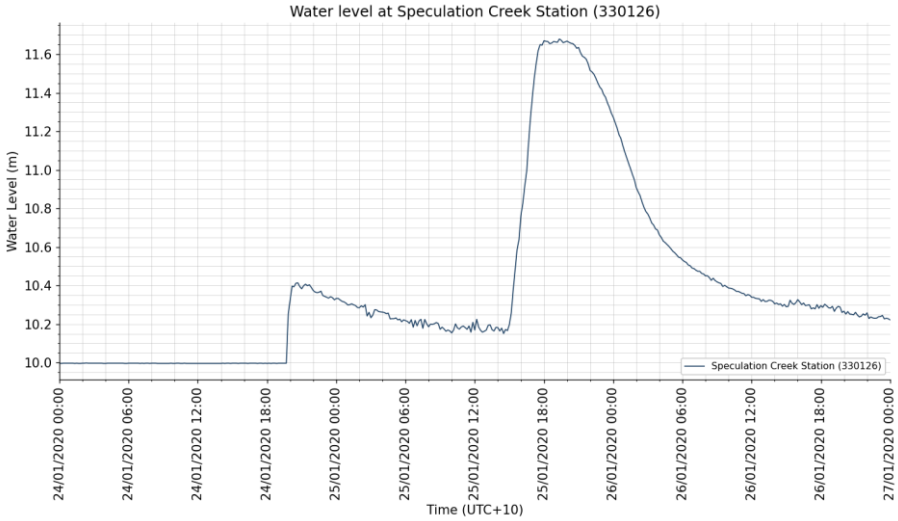


Figure B.15 **Recorded water level at Speculation Creek Station (330126), 2020 event**

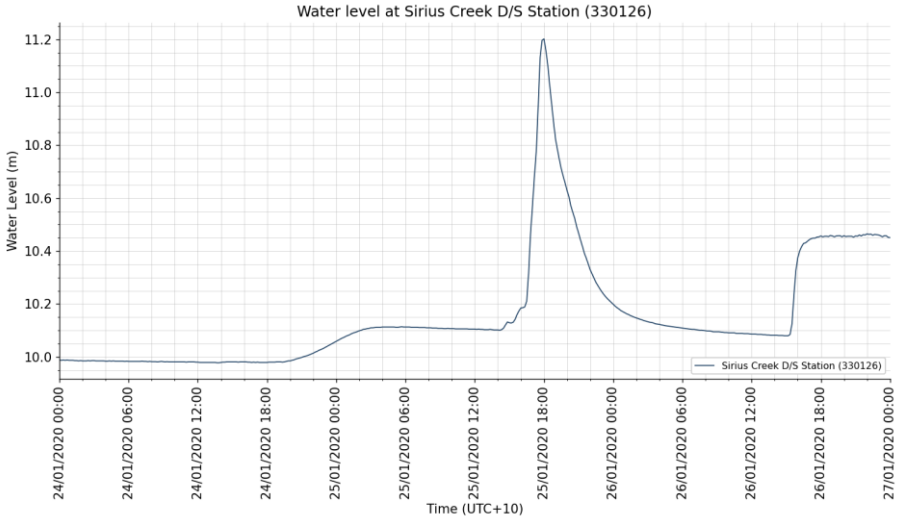


Figure B.16 **Recorded water level at Sirius Creek Station (330118), 2020 event**



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EARTH SCIENCES

Blackwater Mine

Environmental Geochemical Characterisation and Risk Assessment of Mineral Waste

Supporting information for the:

Progressive Rehabilitation and Closure Plan

Prepared for:

Whitehaven Blackwater Pty Ltd

Environmental Geochemical Characterisation and Risk Assessment of Mineral Waste

BLACKWATER MINE

Prepared for:

Whitehaven Blackwater Pty Ltd

DOCUMENT CONTROL

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EXECUTIVE SUMMARY

This report serves to document and discuss the environmental geochemical characteristics of mineral waste materials associated with Blackwater Mine (BWM), as supporting information for the progressive rehabilitation and closure plan (PRCP) for BWM. Until April 2024, BWM was owned and operated by BHP companies, before transferring to Whitehaven Coal. Geochemical data presented herein was collected by BHP prior to April 2024, and Whitehaven Coal thereafter.

The objective of the assessment is to evaluate the geochemical nature of mineral waste currently at BWM and mineral waste likely to be present at closure, and identify relevant environmental issues/opportunities that may be associated with mining, handling and storing mineral waste to inform appropriate rehabilitation and management strategies.

BWM administration and industrial area is located approximately 75 kilometres (km) southeast of Emerald township and about 20 km south of Blackwater township, in central Queensland. BWM is flanked on the east, west and south by pastoral leases; and bounded to the north by Capricorn Highway and Blackwater township. BWM commenced operations in 1967.

BWM comprises typical open-pit coal mining facilities, such as open pits, waste rock (spoil) dumps, tailings storage facilities (TSFs), rejects dumps, coal stockpiles, coal processing facilities, rail loadout facilities, process water and raw water dams, surface water drains and administration areas. The southern area of BWM also contains historic (closed/inactive) underground mining areas.

Current activities of relevance to this waste characterisation report comprise:

- Disposal of spoil to in-pit spoil dumps behind the active mining face (in-pit low-wall spoil disposal);
- Run-of-mine (ROM) coal processing at the north coal handling and preparation plant (NCPP), which produces two mineral waste types:
- Tailings. Clay, silt and very fine to medium-grain sized sand material; disposed as a slurry.
- Rejects. Coarse sand to cobble-sized material.
- Thermal ROM coal processing at the thermal coal plant (TCP), which produces rejects.
- Disposal of tailings from NCPP to Bonnie Doon pit (now Bonnie Doon in-pit TSF); [active from late 2023];
- Disposal of rejects from NCPP and TCP to spoil dumps; Rejects from NCPP have been used in construction of TSF embankments and infrastructure pads;
- Short-term storage of ROM coal on the ROM Pad;
- Short-term storage of product coal on the product coal stockpile, awaiting off-site transport by rail;
- The operation of raw water and process water dams and sediment control structures as stipulated in the EA.

Historic activities of relevance to this waste characterisation report comprise:

- Disposal of tailings from NCPP to the above-ground NCPP TSF; [inactive since late 2023];
- Disposal of rejects from NCPP and TCP to rejects dumps (primarily Ramp 36 rejects dump and TCP rejects dump);
- ROM coal processing at the south coal handling and preparation plant (SCPP), which produced tailings and rejects similar to NCPP. The SCPP received ROM coal from open cut and underground

mining operations in the southern BWM area (what was then called South BWM). SCPP has been inactive since the early 2000s;

- Disposal of tailings from SCPP to the above-ground Laleham TSF, two in-pit TSFs (Kenmare pit - Ramp 72 TSF; and Ramp 74 pit - Ramp 74 TSF) and Bottom Dam TSF (gully southeast of the SCPP ROM 3 pad). Tailings from NCPP were also disposed into Ramp 74 TSF;
- Disposal (rehandling) of mixed 'aged' tailings and rejects (originally from SCPP) into the southern end of Kenmare pit (Ramp 72 pit);
- Disposal of rejects from SCPP onto ROM Pad 3 and into Bottom Dam area adjacent to Bottom Dam TSF.

Material types and quantities

BWM has three main types of mineral waste, and the geochemical characteristics and potential hazards associated with mineral waste materials on site are discussed by type:

- Spoil (overburden and interburden) currently comprises approximately 99% of all mineral waste at BWM and includes weathered waste (Tertiary and Permian-age) and fresh (unweathered) waste (all Permian-age). On average, approximately 40% of spoil is weathered/oxidised and the remaining (approximately 60%) is fresh, with the proportion of weathered to fresh spoil varying throughout the site. In the northern half of the site the proportion of weathered to fresh spoil is about 25% weathered to 75% fresh, whereas in the southern half of the site weathered and fresh spoil are present in approximately equal proportions.
- Tailings are generated at the NCPP (and previously also at the SCPP) from processing ROM coal and typically represent the clay, silt and fine sand fractions of ROM waste. Throughout operations at BWM, tailings has been disposed as a slurry into a number of TSFs – the current (active) TSF being Bonnie Doon in-pit TSF. Tailings comprises approximately 0.5% of all mineral waste at BWM – with this approximated proportion expected for the remaining life of asset mine plan.
- Rejects are generated at the NCPP (and previously also at the SCPP) from processing ROM coal and typically represents coarser and rockier seam roof, partings and floor material. Rejects are trucked to several locations for disposal into spoil. Historically, rejects were also disposed onto rejects dumps, such as Ramp 36 rejects dump and Bottom Dam TSF [mixed tailings and rejects]. Some rejects have been used in construction of TSF embankments and infrastructure pads (e.g. ROM and coal stockpile pads). Rejects comprise approximately 0.5% of all mineral waste at BWM – with this approximated proportion expected for the remaining life of asset mine plan.

Coal is also included in the assessment; however, coal is generally not considered mineral waste, with the exception of small quantities of sub-economic seams that may report to the spoil dumps, and remnant coal exposed on pit highwalls and end-walls (such as in residual voids).

AMD Potential of Mineral Waste and Coal

Mineral waste samples have undergone environmental geochemical characterisation and assessment with regard to their potential to generate acid and metalliferous drainage (AMD), which comprises acid drainage (AD), neutral and metalliferous drainage (NMD) and/or saline drainage (SD) [salinity due to sulfate derived from sulfide oxidation]. Additionally, samples have been assessed with regard to their potential to generate salinity (non-oxidative) and, for spoil materials, their sodicity and dispersion potential.

AMD potential of spoil – non-carbonaceous

Non-carbonaceous spoil, which comprises about 92% of spoil, is expected to generate pH-neutral to highly alkaline contact water (run-off and seepage), which is typical for mine spoil in the Bowen Basin.

Based on the results from 4172 samples (657 weathered and 3515 fresh), non-carbonaceous spoil has a very low potential to generate AMD as either AD and/or NMD and/or SD, but for a small proportion that is assessed to have a higher potential to generate AMD (as AD, NMD and/or SD). However, in consideration of the mixing and dispersion of a small volume of waste at higher potential for AMD within the broader spoil material, the overall potential for non-carbonaceous spoil (and bulk spoil, generally) to generate AMD is assessed to be low.

The total sulfur (S) concentration of non-carbonaceous spoil is very low, with a 95th percentile total S concentration of 0.09%. As such, and combined with moderate to high acid neutralising capacity (ANC) values [median = 40 kilograms of sulfuric acid per tonne of rock (kg H_2SO_4/t)], which is significantly higher than the maximum potential acidity (MPA) [median 0.6 kg H_2SO_4/t], approximately 97% of non-carbonaceous spoil samples tested were classified as non-acid forming (NAF), with a further 1.3% (approximately) of samples classified as UC(NAF) [uncertain, but expected to be NAF]. Less than 1.5% of non-carbonaceous spoil samples were classified as potentially acid forming (PAF), PAF-LC [PAF, low capacity], UC(PAF) [uncertain, but expected to be PAF or PAF-LC] or NAF-S [NAF, but with total S greater than 1%]. Only one sample was classified as NAF-S.

The test-work has demonstrated that the ANC for the non-carbonaceous spoil is generally expected to be about 36-73% available under field conditions (based on 25th and 75th percentile values), with iron-dolomite/dolomite and calcite being the main carbonate minerals contributing to the acid buffering potential of the non-carbonaceous spoil. Overall, non-carbonaceous spoil has excess acid neutralising capacity and is expected to be bulk acid consuming.

Total metal and metalloid concentrations from 548 non-carbonaceous spoil samples tested are very low compared to average element abundance in soil in the earth's crust. Fourteen samples (<3% of samples) were significantly enriched with regard to one or more of arsenic (As), barium (Ba), cobalt (Co), chromium (Cr), mercury (Hg), S and/or selenium (Se). The enrichment in one or more of these elements in a small proportion of samples is not cause for concern. Of the samples displaying elemental enrichment, there was no correlation with AMD classifications of these samples. In summary, non-carbonaceous spoil has low enrichment in total metals and metalloids compared to un-mineralised rocks.

Soluble multi-element results (from 549 non-carbonaceous samples) indicate that leachate from this material is expected to contain low concentrations of soluble metals and metalloids under pH-neutral to alkaline conditions. About 6% of samples produced moderate soluble metal concentrations under pH-neutral to alkaline leaching conditions; and about 4% of samples (almost all weathered) produced low soluble metal concentrations under weakly acidic leaching conditions. The remaining 1% (approximately) of samples produced moderate to elevated metals under weakly acidic conditions. Peroxide leaching undertaken on 14 non-carbonaceous spoil samples showed that PAF material has the potential to generate low pH leachate (AD) with moderate sulfate and soluble metal and metalloid concentrations.

AMD potential of spoil – carbonaceous

Carbonaceous spoil represents less than 8% of spoil material at BWM and – as a bulk material – is expected to generate pH-alkaline to highly alkaline contact water (run-off and seepage), similar to non-carbonaceous spoil.

Based on the results from 292 samples (nine weathered and 283 fresh), carbonaceous spoil has a generally low potential to generate AD and/or NMD and/or SD. Some carbonaceous spoil – mostly associated with coal seams – has a greater potential to generate low-level AD and/or NMD and/or SD.

The total S concentration of carbonaceous spoil is low, with 95th and 75th percentile total S concentrations of 0.59% and 0.25%, respectively. Approximately 85% of (248 out of 292) carbonaceous spoil samples were classified as NAF, with a further 4 samples (approximately 1.4% of samples) classified as UC(NAF). The remaining 14% (approximately) of samples were classified as PAF, PAF-LC, UC(PAF) or NAF-S and had a low-moderate 75th percentile total S value of 0.72%. Only two samples were classified as NAF-S. Most of the 'PAF' and NAF-S carbonaceous spoil samples were closely associated with coal seams.

The test-work undertaken has demonstrated that the ANC is generally expected to be about 17-41% available under field conditions (based on 25th and 75th percentile values), with iron-dolomite/dolomite and calcite being the main carbonate minerals contributing to the acid buffering potential of carbonaceous spoil. Overall, carbonaceous spoil has relatively modest acid neutralising capacity.

Total metal and metalloid concentrations from 69 carbonaceous spoil samples tested are very low compared to average element abundance in soil in the earth's crust, and very similar to the assay concentrations from non-carbonaceous spoil. Twelve samples were significantly enriched with regard to one or more of As, copper (Cu), Hg, S and/or uranium (U). Of the samples displaying elemental enrichment, there was no correlation with AMD classifications of these samples. In summary, carbonaceous spoil has low enrichment in total metals and metalloids compared to un-mineralised rocks.

Soluble multi-element results (from 69 samples) indicate that, with few exceptions, leachate from carbonaceous spoil is expected to contain low concentrations of soluble metals and metalloids – similar to non-carbonaceous spoil samples. Peroxide leaching undertaken on six carbonaceous spoil samples (mixed 'NAF' and 'PAF') showed that the PAF samples have the potential to generate low pH leachate (AD) with moderate sulfate and soluble metal and metalloid concentrations. Most of the 'NAF' samples that underwent peroxide leaching produced leachate with near-neutral to alkaline pH and with low to moderate soluble metals concentrations.

AMD potential of tailings

The geochemical characteristics differed between fresh tailings from the NCPP versus aged tailings from TSFs for different parameters – particularly total S (and, by inference, MPA), ANC and pH. However, the overall geochemical (AMD) hazard posed by tailings from the two sources (fresh vs aged) was generally similar. As such, the discussion that follows only differentiates between the two tailings sources where the differences between the two sources was significant for some parameters and worthy of discussion. Else, the AMD potential of tailings is discussed as a bulk material.

Based on the results from 703 samples, approximately 55% of tailings has a moderate to high potential to generate AMD as either AD and/or NMD and/or SD, and the remaining 45% (approximately) has a relatively low potential to generate AMD as either AD and/or NMD and/or SD.

Fresh tailings from the NCPP are expected to generate pH-alkaline to highly alkaline contact water (run-off and seepage). Overall, aged tailings have lower pH compared to fresh tailings, however the pH in aged tailings ranged from moderately acidic to pH-alkaline. The difference in pH observed between fresh and aged tailings (and the differences within the aged tailings) may be due to a number of factors, however the most likely cause is oxidation processes consuming readily available neutralising minerals, leading to aged tailings generally having a low(er) acid neutralising potential.

The total S concentration of tailings is generally low-moderate, with median values of 0.76% and 0.52% for fresh and aged tailings, respectively. Overall, the total S concentration was higher in the fresh tailings compared to the aged tailings. The reasons for differences in total S between the fresh versus aged tailings is unclear and potential processes that could account for differences in total S concentration are:

- Sulfide oxidation and neutralisation reactions ongoing within the TSFs, which generate sparingly and / or readily soluble sulfate. Therefore, sulfur mass loss could have occurred from aged tailings due to leaching of sulfate minerals, such as jarosite, alunite and/or gypsum and/or readily soluble acid salts (e.g. iron sulfate 'salts' such as melanterite or copiapite).
- Change in geochemistry of ROM coal being processed. That is, ROM coal becoming more S-rich over time due to a change in the relative proportions of the various coal seams/plys being mined and processed.
- Addition of sulfate via salt precipitation within tailings during drying/evaporation of slurry water (liquor) [laboratory bias].

In the fresh tailings samples about 69% (median value) of the total S is present as sulfide (Scr). Comparatively, only 48% (median value) of the total S is present as Scr in the aged tailings samples. The difference in the proportion of total S as Scr between fresh versus aged tailings is typical and expected – supporting the suggestion that the aged tailings in the TSFs are being oxidised since deposition (sulfide oxidised to sulfate).

Just as there were notable differences between the total S concentrations in fresh versus aged tailings, so too with the ANC values of fresh versus aged tailings. Fresh tailings had generally moderate to high ANC values (median 32 kg H_2SO_4/t) compared to aged tailings, which had generally low to moderate ANC values (median 16 kg H_2SO_4/t). The reason behind the lower ANC observed in aged tailings (compared to fresh tailings) is not well understood. However, it is likely related to ANC being consumed via buffering of acidity generated by sulfide oxidation and/or sulfate leaching. Other processes that could account for a difference in ANC between fresh and aged tailings include inherent differences in the geochemical properties of the coal from earlier mining compared to recent mining, and/or – related to ROM coal differences; and it may also be partially due to differences in processing methods between the NCPP and the SCPP.

Based on the above generally low-moderate total S values (and, therefore, MPA values) combined with a wide range of ANC values resulted in approximately 55% of tailings samples being classified as PAF, PAF-LC, UC(PAF) or NAF-S – with the remaining 45% (approximately) classified as NAF or UC(NAF). Of the 'PAF' and NAF-S tailings samples, about 72% were classified as UC(PAF) or PAF-LC.

The test-work undertaken has demonstrated that the ANC in fresh tailings is expected to be about 47-67% available under field conditions, compared to about 12-63% available for aged tailings. Iron-dolomite/dolomite and calcite are expected to be the main carbonate minerals contributing to the acid buffering potential of tailings.

OxCon test-work undertaken on five fresh and one aged tailing samples found that two of the fresh tailings samples expected to be NAF or NAF-S were confirmed to be NAF and were unlikely to be generating AD or NMD. The remaining three fresh tailings samples, which were expected to be 'PAF' were confirmed to be PAF or PAF-LC and were found to pose a moderate to moderate-high risk of generating AD and low potential for SD. The aged tailings sample from NCPP TSF was confirmed as PAF and found to pose high potential for generating AD and low potential for SD.

With few exceptions, the total metal and metalloid concentrations from 56 tailings samples tested are generally low compared to average element abundance in soil in the earth's crust. About 26% of the fresh tailings samples and 29% of the aged tailings samples were significantly enriched with regard to S, which is consistent with the ABA data. Two aged tailings samples were significantly enriched with regard to silver (Ag). The GAI values also show that most of the tailings samples tested had minor enrichment (GAI = 1 or 2) with regard to S, which was consistent with the ABA data. There was no clear correlation found between AMD classifications of the tailings samples compared to elemental enrichment.

Solubility data indicate that under freshwater (deionised water) leaching conditions about 73% of tailings samples have low soluble metals concentrations and have near-neutral to alkaline pH, including all 39 fresh NCPP tailings samples. The remaining 27% of tailings samples – all aged – have a wide range of soluble metals concentrations under a wide range of pH conditions. Generally, the NCPP TSF and Laleham TSF tailings samples had similar soluble metals concentrations, however the Laleham TSF samples had lower pH compared to the aged tailings samples from NCPP TSF. Under saline leaching conditions fresh tailings produced low concentrations of soluble metals and metalloids.

Peroxide leaching undertaken on 48 tailings samples [about 60% classified as 'PAF' or NAF-S, and the remainder classified as NAF or UC(NAF)] showed that when exposed to highly oxidising conditions a significant proportion of tailings can produce weakly to highly acidic leachate with elevated soluble metals and metalloid concentrations. However, about one-third of tailings samples appeared to be influenced to some degree by the presence of organic acids, due to the samples' high organic carbon concentration. The presence of organic acids likely accounts, to some degree, for the acidity and 'elevated' soluble metals and metalloid concentrations evident in these tailings. Nevertheless, PAF tailings [including tailings classified as UC(PAF)] have typically produced moderate to elevated soluble metals and metalloid concentrations from the freshwater and peroxide leaching tests. These results indicate that PAF tailings have the potential to generate low pH leachate (AD), however the salinity (sulfate) loads are not expected to be high – due to generally low total S concentrations (with minor exceptions).

AMD potential of rejects

Based on the results of 398 samples, about 45% of the rejects have a moderate to high potential to generate AMD as either AD and/or NMD and/or SD, whereas the remaining 55% (approximately) of rejects has a relatively low to low-moderate potential to generate AMD as either AD and/or NMD and/or SD.

Fresh rejects from the NCPP are expected to generate highly pH-alkaline contact water (run-off and seepage). Aged rejects (from TSFs, Ramp 36 rejects dump and a small number of rejects in the Red Dam area) has lower pH compared to fresh rejects and is expected to generate weakly acidic to pH-alkaline contact water (run-off and seepage). The difference in pH observed between fresh and aged rejects – with the latter showing generally lower pH – may be due to a number of factors, however the most likely cause is oxidation processes consuming readily available neutralising minerals, leading to aged rejects having a low(er) acid neutralising potential.

The total S concentration of fresh rejects was generally low (median value = 0.28%) compared to aged rejects, which had low to low-moderate total S values (median value = 0.61%). Aged rejects have come from multiple pit locations (different ROM coal) and processed from different CHPPs (NCPP and SCPP).

In the fresh rejects samples about 74% (median value) of the total S is present as sulfide (Scr), and in the aged rejects samples about 59% (median value) of the total S is present as Scr. The difference in the proportion of total S as Scr between fresh versus aged rejects is typical and expected – supporting the

suggestion that the aged rejects in the TSFs and rejects dump(s) are being oxidised since deposition (sulfide oxidised to sulfate). Aged rejects may have been in place for nominally 5 to 30 years.

Just as there were notable differences between the total S concentrations in fresh versus aged rejects, so too with the ANC values of fresh versus aged rejects. Fresh (NCPP) rejects had generally moderate to very high ANC values (median 40 kg H_2SO_4/t) compared to aged rejects, which had generally low to high ANC values (median 18 kg H_2SO_4/t). The reason behind the lower ANC observed in aged rejects (compared to fresh rejects) is not well understood. However, it is likely related to ANC being consumed via buffering of acidity generated by sulfide oxidation and/or sulfate leaching. Other processes that could account for a difference in ANC between fresh and aged rejects include inherent differences in the geochemical properties of the coal from earlier mining compared to recent mining, and/or – related to ROM coal differences; and it may also be partially due to differences in processing methods between the NCPP and the SCPP.

Based on the above generally low to low-moderate total S values (and, therefore, MPA values) combined with a wide range of ANC values resulted in approximately 45% of rejects samples (all being aged rejects) being classified as PAF, PAF-LC, UC(PAF) or NAF-S – with the remaining 55% (approximately) classified as NAF or UC(NAF). All fresh rejects were classified as NAF.

The test-work undertaken has demonstrated that the ANC in fresh rejects is expected to be about 50-78% available under field conditions, compared to about 25-60% available for aged rejects. Iron-dolomite/dolomite and calcite are expected to be the main carbonate minerals contributing to the acid buffering potential of rejects.

No fresh rejects samples were significantly enriched with metals or metalloids. Four out of 17 aged rejects samples were significantly enriched with regard to S, which is consistent with ABA data for these samples. There was no correlation found between AMD classifications of the reject samples compared to elemental enrichment.

Solubility data indicate that under freshwater (deionised water) leaching conditions about 65% of rejects samples have low soluble metals concentrations and have near-neutral to alkaline pH, including all 15 fresh NCPP rejects samples. The remaining 35% of rejects samples – all aged – have a wide range of soluble metals concentrations under a wide range of pH conditions. Most of the aged rejects with lower pH and moderate to elevated soluble metals concentrations were from Ramp 72 (Kenmare pit rejects).

Peroxide leaching undertaken on 26 aged rejects samples of predominantly 'PAF' classifications showed that almost all rejects samples were weakly to highly acidic and had moderate to elevated metal and metalloid concentrations. The results suggest that under acid/acidic conditions, materials represented by these aged reject samples are capable of generating elevated metal and metalloid loads for several metals/metalloids, however the sulfate (and salinity) loads are not expected to be high – due to the generally low total S concentration (with some exceptions).

AMD potential of coal

Coal is not regarded as waste and run-of-mine (ROM) coal remains on-site for a relatively short period of time. However, some minor coal seams/plys will report directly as waste, and remnant coal (seams) will be exposed on the highwalls and end-walls of residual voids at closure.

Coal represents about 5% of all lithological material at BWM (i.e. about 2% to 7% of the highwall / end-wall meterage, depending on the void). Assuming the large majority of this will report as ROM coal, it is assumed that coal will represent a very small proportion of mineral waste (i.e. nominally 1-2%).

Based on the results of 381 samples, ROM coal is assessed as having a low-moderate to moderate potential to generate AMD as either AD, NMD and/or SD. A small proportion of coal would have a moderate to moderate-high potential to generate AMD. ROM coal, as a bulk material, is expected to generate pH-alkaline to highly alkaline contact water (run-off and seepage).

The total S concentration of coal is generally low (95th percentile total S concentration of 0.62%) and approximately 14% (median value) of the total S is present as sulfide (Scr), with the bulk of the total S likely present as organic S, which does not contribute to AMD. Coal samples have a wide range of ANC values; however, the median ANC is low (median = 11 kg H_2SO_4/t). As such, 64% of coal samples were classified as NAF or UC(NAF). One sample was classified as NAF-S. The remaining 35% (approximately) of samples were classified as PAF, PAF-LC or UC(PAF) and were from all seam groups. The AMD classification is based on total S, which for coal samples likely leads to highly conservative classification given that most sulfur in coal is organic S, not sulfidic S. These results suggest that coal stored on the ROM pad, coal located within pit walls and un-economic coal seam material reporting as spoil (mixed with non-coal spoil) would likely be bulk NAF.

Assay data for 72 coal samples show that the total metal and metalloid concentrations are generally low compared to average element abundance in soil in the earth's crust. Three coal samples were significantly enriched with regard to one or more of As and/or S.

Solubility data indicate that under freshwater (deionised water) leaching conditions about 88% of the 72 coal samples tested have low soluble metals concentrations and have near-neutral to alkaline pH. The remaining 12% of coal samples have a wide range of soluble metals concentrations under a wide range of pH conditions (moderately acidic to alkaline). These results indicate that some ROM coal is capable of generating AD and/or SD/NMD.

Salinity, Sodicity and Dispersion Potential of Mineral Waste and Coal

Salinity, sodicity and dispersion potential of spoil – non-carbonaceous

Non-carbonaceous spoil has low median and 95th percentile $EC_{1:5}$ values of 344 and 569 microSiemens per centimetre (μS/cm), respectively, and has very low total S concentrations. On this basis, contact water (run-off and seepage) is expected to be generally non-saline to slightly saline, as a result of dissolution of geogenic salts more so than from sulfide oxidation (sulfate salinity). Weathered non-carbonaceous spoil generally has similar $EC_{1:5}$ values compared to fresh non-carbonaceous spoil.

Non-carbonaceous spoil has low cation exchange capacity (CEC) values and generally high exchangeable sodium percentage (ESP) values, resulting in approximately 91% of samples being classified as 'strongly sodic' or 'sodic' and, therefore, with potential for dispersion. Based on Emerson aggregate class testing to directly measure dispersion, about 59% of the non-carbonaceous spoil samples displayed some degree of dispersion. Although not entirely consistent with the ESP results, the Emerson Class test results suggest a significant proportion of non-carbonaceous spoil would be dispersive.

Salinity, sodicity and dispersion potential of spoil – carbonaceous

Carbonaceous spoil has generally low median and 95th percentile $EC_{1:5}$ values of 328 and 574 μS/cm, respectively, and has low total S concentrations. On this basis, contact water (run-off and seepage) is expected to be similar to non-carbonaceous spoil. That is, generally non-saline to slightly saline, primarily as a result of dissolution of geogenic salts more so than from sulfide oxidation (sulfate salinity).

Carbonaceous spoil samples had comparable CEC and ESP values to non-carbonaceous spoil – with the main difference being the weathered carbonaceous samples having generally higher CEC and much lower ESP compared to the fresh carbonaceous samples. This resulted in most fresh carbonaceous samples being classified as 'strongly sodic' whereas the three weathered samples were all classified as 'non-sodic'. As such, and based solely on the moderate to high sodicity values, carbonaceous spoil is expected to be sodic (to some degree) with potential for dispersion. Based on Emerson aggregate class testing to directly measure dispersion, about half of the samples displayed some degree of dispersion, suggest a significant proportion of carbonaceous spoil would be dispersive.

Salinity potential of tailings

Tailings samples (n=698) have $EC_{1:5}$ values ranging from 97 to 8900 μS/cm, with median, 75th and 95th percentile $EC_{1:5}$ values of 714, 1008 and 1976 μS/cm, respectively. There is generally little difference in $EC_{1:5}$ values between fresh and aged tailings, with both types being generally slightly to moderately saline. The generally low to low-moderate total S for aged tailings and low-moderate to moderate total S for fresh tailings conservatively suggests a low-moderate to moderate potential for SD (from sulfide oxidation).

Salinity potential of rejects

Rejects samples (n=398) have $EC_{1:5}$ values ranging from 123 to 2830 μS/cm, with median, 75th and 95th percentile $EC_{1:5}$ values of 797, 1398 and 2343 μS/cm, respectively. Fresh rejects samples were all generally non-saline whereas aged rejects were generally slightly to moderately saline. The generally low total S for fresh rejects and low to low-moderate total S for aged rejects conservatively suggests a low to low-moderate potential for SD (from sulfide oxidation).

Salinity potential of coal

Coal samples (n=381) have $EC_{1:5}$ values ranging from less than 10 to 722 μS/cm, with low median and 95th percentile $EC_{1:5}$ values of 99 and 332 μS/cm, respectively. Coal has generally low total S concentrations. On this basis, contact water (run-off and seepage) from coal, as a bulk material, is expected to be non-saline.

Geochemical Source Hazard Assessment of Mineral Waste and Coal

A geochemical source hazard assessment was applied to the source material types comprising carbonaceous and non-carbonaceous spoil, tailings, rejects and coal (where relevant). The source hazard score is a formula that takes into account the propensity to generate AMD, the AMD capacity (severity) and the quantity (volume) of material that could produce AMD. The AMD source hazard scores are as follows:

- Spoil – non-carbonaceous: AMD source hazard score = **Low**
- Spoil – carbonaceous: AMD source hazard score = **Low-Moderate**
- Tailings: AMD source hazard score = **Moderate-High** (score ranged from Moderate-High to High depending upon the TSF facility, but was generally Moderate-High)
- Rejects: AMD source hazard score = **Moderate to Moderate-High** (score ranged from Low-Moderate to Moderate-High depending upon the rejects facility, but was generally Moderate to Moderate-High)
- Coal: AMD source hazard score = **Low-Moderate**

When combined, and taking into account the proportion of material that could generate AMD relative to the total proportion of all materials in a final landform (spoil or TSF or rejects landform and residual voids), the AMD hazard score for the landforms, void highwalls / end-walls and void floors at closure has been determined.

Spoil landforms

There are 14 spoil landforms at BWM that will remain at closure:

- Ramp 8
- Bonnie Doon
- Mimosa-Besgrove
- Deep Creek
- Stewarton
- Tannyfoil
- Blackdown
- South Ballamoo
- Kenmare
- Ramp 74
- Togara-North Marshmead
- South Marshmead
- Kennedy
- Comet Downs East

Each landform will have a similar construction, comprising mined overburden and interburden disposed behind the active mining face to form a low-wall spoil dump, which will be reshaped to form a final spoil landform.

Mimosa-Besgrove, Deep Creek, Stewarton, Kenmare and Togara-North Marshmead spoil landforms contain a small proportion of existing or planned future rejects (between 0.2% and 1.9%, depending on the landform). Kenmare spoil landform also comprises approximately 1% existing tailings, located at Ramp 72 in-pit TSF.

Taking into account material quantities (proportions) and expected proportion of PAF and NAF-S materials reporting to each individual landform:

- Each of the 14 spoil landforms poses a **Low** AMD hazard, with AMD generation rated as **Highly Unlikely**.

The 'Low' AMD hazard is largely a result of less than 1.5% of non-carbonaceous spoil samples being classified as PAF of some type (or NAF-S) – and non-carbonaceous spoil comprises the overwhelming majority of mineral waste within each spoil landform.

Regarding Kenmare spoil landform specifically, the intrinsic AMD hazard of Ramp 72 TSF/tailings and rejects located at the southern end of the existing Kenmare pit – both of which will be contained (buried) within Kenmare spoil landform – is rated **Moderate-High to High** with the likelihood to generate AMD rated **Highly Likely** – due to AMD (as AD) having been observed from Ramp 72 TSF and from rejects within the existing Kenmare pit. Ramp 72 TSF and the rejects disposal area at the southern end of Kenmare pit are both within the Kenmare pit (void) shell. Rejects located near Ramp 70 within Kenmare spoil landform (at the northern end of the landform) pose a **Moderate** AMD hazard, with the likelihood to generate AMD rated **Probable/Likely**.

NCPP TSF landform

NCPP TSF is a large 'turkey's nest' style TSF with confining embankments on all sides, a base footprint of approximately 200 ha and has a total volume of approximately 26 Mm^3. NCPP TSF operated from approximately 1970 to 2023.

The source materials within NCPP TSF includes tailings, which are estimated to comprise approximately 80% of the landform; and rejects, which are estimated to comprise about 19% of the landform and form the basis of most of the embankments. The TSF landform also includes a small proportion (approximately 1 %) of spoil/fill material, predominantly within embankments.

Investigative drilling coupled with near-surface sampling has demonstrated that some tailings in the field at NCPP TSF are generating AMD (as AD and SD). Oxidation fronts are present in the TSF as demonstrated by decreasing sulfide concentrations from surface down, consumption of ANC, presence of secondary minerals generated through sulfide oxidation, and acid contact pH water.

The source hazard assessment for the mineral wastes within NCPP TSF landform has utilised the same general methodology as applied to the spoil landforms and other TSF and reject landforms. The source hazard assessment has found the tailings within NCPP TSF landform poses a **High** AMD source hazard; and rejects poses a **Low-Moderate** AMD source hazard. Fill material poses a low AMD source hazard. On this basis, and taking into account material quantities (proportions):

- NCPP TSF landform (currently, without a rehabilitation cover) poses a **Moderate-High** AMD hazard, with AMD generation rated as **Highly Likely**, the highest landform AMD likelihood category under the applied scoring procedure – noting that AMD has already been observed at/from this TSF. The AMD hazard is considered to predominantly lie with the tailings, and lesser so the rejects.

The AMD hazard score for the tailings and rejects materials is considered to be conservative and the landform domain AMD hazard score for NCPP TSF is also considered to be conservative.

Laleham TSF landform

Laleham TSF is largely constructed over spoil/fill (and also backfills a small pit). The TSF partly fills the upper reaches of a southeasterly plunging gully. The TSF abuts natural ground on the north and northwest, and overlies spoil/fill on the south and southeast. The TSF has a total area of approximately 12 ha and a total volume of approximately 4 Mm^3. The TSF operated from the late-1970s to the late-1980s, primarily receiving tailings from Laleham underground operation. Between 1990 and 1994 a thin spoil/soil cap was placed over the TSF and seeded/revegetated. This TSF has undergone rehabilitation and revegetation since decommissioning, however additional rehabilitation is assumed to be required prior to closure.

The source materials within Laleham TSF includes tailings, which are estimated to comprise approximately 90% of the landform; and rejects, which are estimated to comprise about 4% of the landform. The TSF embankments (main embankment and upper embankment) are predominantly constructed from spoil and fill material, which comprise about 6% of the TSF.

Investigative drilling has demonstrated that tailings in the field at Laleham TSF are generating AMD (as AD and SD). Oxidation fronts are present in the TSF as demonstrated by decreasing sulfide concentrations from surface down, consumption of ANC, presence of secondary minerals generated through sulfide oxidation, and acid contact pH water.

The source hazard assessment for the mineral wastes within Laleham TSF landform has utilised the same general methodology as applied to the spoil landforms and other TSF and reject landforms. The source hazard assessment has found the tailings within Laleham TSF landform poses a **Moderate-High** AMD source hazard; and rejects pose a **Moderate** AMD source hazard. Fill material poses a low AMD source hazard. Evidence of AMD (as AD) is present from over 30% of the tailings samples collected from within the TSF. On this basis, and taking into account material quantities (proportions):

- Laleham TSF landform (currently, without a final rehabilitation cover[1]) poses a **Moderate-High** AMD hazard, with AMD generation rated as **Probable/Likely**. The AMD hazard is considered to predominantly lie with the tailings, and lesser so the rejects.

The AMD hazard score for the tailings and rejects materials is considered to be conservative and the landform domain AMD hazard score for Laleham TSF is also considered to be conservative.

Bottom Dam TSF and rejects landform

Bottom Dam TSF is a small historic tailings dam south of ROM 3 near the SCPP in the southern area of BWM. Adjacent to the TSF, and in the general vicinity of the TSF (including on ROM 3), are rejects dumps. ROM 3 is an elevated natural ground area northwest of Bottom Dam TSF and situated approximately 37 m above (higher than) the TSF.

The TSF (specifically) occupies an area of approximately 1.6 ha (with an estimated total volume of approximately 0.2 Mm^3). The overall Bottom Dam TSF/rejects area is approximately 10 ha, with an overall tailings/rejects volume estimated at less than 1 Mm^3 (indicatively 0.6 to 0.8 Mm^3). The source materials within Bottom Dam TSF includes tailings, which are estimated to comprise approximately 95% of the landform; and rejects, which are estimated to comprise about 4% of the landform. The TSF landform is also assumed to include a small proportion (approximately 1 %) of spoil/fill material.

Tailings and rejects in Bottom Dam TSF/rejects were generated from the SCPP and are reasonably assumed to have environmental geochemical characteristics comparable to tailings and rejects located within Ramp 72 TSF, Kenmare pit and Laleham TSF. Preliminary investigative drilling and limited sampling has demonstrated that all tailings at Bottom Dam TSF are classified as 'PAF' of some type and most show evidence of generating AMD (as AD and SD).

The source hazard assessment for the mineral wastes within Bottom Dam TSF landform has utilised the same general methodology as applied to the spoil landforms and other TSF and reject landforms. The source hazard assessment has found the tailings within Bottom Dam TSF landform poses a **Moderate-High** AMD source hazard and rejects pose a **Moderate** AMD source hazard. Fill material poses a low AMD source hazard.

On this basis, and taking into account material quantities (proportions):

- Bottom Dam TSF landform (currently, without a rehabilitation cover) poses a **Moderate-High** AMD hazard, with AMD generation rated as **Probable/Likely**. The AMD hazard is considered to predominantly lie with the tailings, and lesser so the rejects.

The AMD hazard score for the tailings and rejects materials in Bottom Dam area is considered to be conservative and the landform domain AMD hazard score for Bottom Dam area (TSF and rejects combined) is also considered to be conservative.

Ramp 36 rejects landform

Ramp 36 rejects dump will remain as a 'stand-alone' rejects landform at closure. The dump is located approximately one km south of the NCPP and about 350 m southeast of NCPP TSF. The dump occupies an area of approximately 60 ha with a total estimated volume of approximately 10 Mm^3. The dump operated from approximately 1967 (start of mining at BWM) intermittently through until 2007. During

1 Laleham TSF currently has a spoil cover, however additional rehabilitation is expected to be required to meet post-closure rehabilitation criteria. As such, the AMD hazard assessment of Laleham TSF takes into consideration the existing cover material, however considers the facility to be 'unrehabilitated'.

this time, rejects have been taken (quarried) from the dump for use elsewhere on site – primarily for construction of the NCPP TSF embankments.

Ramp 36 rejects dump essentially comprises only rejects (approximately 98% by volume). A small amount of 'fill' (assume spoil) is also present and has been conservatively estimated to comprise about 2% of the landform.

The source hazard assessment for the mineral wastes within the rejects dump has utilised the same general methodology as applied to the spoil and TSF landforms. The source hazard assessment has found the rejects within the dump poses a **Moderate-High** AMD source hazard. Fill material has been assessed as posing a low AMD source hazard. Taking into account material quantities (proportions):

- Ramp 36 rejects dump (currently, without a rehabilitation cover) poses a **Moderate-High** AMD hazard, with AMD generation rated as **Probable/Likely**. The AMD hazard lies with the rejects, which comprise essentially all of the dump.

The AMD hazard score for the rejects materials is considered to be conservative and the landform domain AMD hazard score for the rejects dump is also considered to be conservative.

Residual voids

There are 15 existing and/or future pit areas at BWM that will remain at closure as residual voids. All except two correspond to the spoil landforms as previously identified. Stewarton pit will be mined into two voids (Stewarton North and Stewarton South). Blackdown pit (located between Tannyfoil and South Ballamoo pits) will be backfilled, and therefore has no associated residual void. Ramp 30S void is associated with Mimosa-Besgrove spoil landform:

- Ramp 8 void
- Bonnie Doon void (in-pit TSF)
- Mimosa-Besgrove void
- Ramp 30S void
- Deep Creek void
- Stewarton North void
- Stewarton South void
- Tannyfoil void
- South Ballamoo void
- Kenmare void (in-pit TSF)
- Ramp 74 [Laleham] void (in-pit TSF)
- Togara-North Marshmead void
- South Marshmead void
- Kennedy void
- Comet Downs East void

Excluding the Bonnie Doon and Ramp 74 residual voids that have tailings on the pit/void floor, the floor of all residual voids at closure will be the P & L Lower seam group, which is currently the floor of most/all existing pits.

Environmental geochemical data, coal quality data and drill-hole geological logs have been used to aid in the assessment of AMD risk associated with residual void highwalls / end-walls and floors.

The highwall /end-wall hazard assessment has found that approximately 3.5% to 6% of the void highwall and end-walls in all voids is estimated to be PAF, which includes material classified as UC(PAF), PAF-LC and NAF-S. As such, the assessment has found that the likelihood of AMD generation from the void highwalls and end-walls is **Unlikely**, and any expression of AMD from the highwall / end-walls is likely to be localised.

Excluding Bonnie Doon and Ramp 74 voids, which have tailings on their floor, the floor of all other residual voids will be the P & L (lower) seam. On the highly conservative (if not overly conservative)

assumption that the floor of each of these non-tailings voids is all coal, the void floor AMD hazard assessment has found that approximately 3% of the floor of these voids where coal is exposed is estimated to be 'PAF', which includes material classified as PAF, UC(PAF), PAF-LC and NAF-S. As such, the conservative assessment has found that the likelihood of AMD generation from the floor of these voids where coal is exposed is **Unlikely**, until such time that the floor becomes submerged by groundwater (post-closure). In practice, mining takes all coal to the bottom of the seam, therefore very little coal would be expected to remain on the floor of these voids.

Bonnie Doon and Ramp 74 voids have tailings as the void floor and the source hazard assessment – based on the AMD hazard posed by tailings – has found that approximately 46% of the floor of Bonnie Doon void and 72% of the floor of Ramp 74 void is estimated to be 'PAF' [tailings], which includes tailings classified as PAF, PAF-LC, UC(PAF) and/or NAF-S. AMD generation from the floor of these TSF voids is **Probable/Likely**. The tailings within these voids will be capped/covered at end of mining and no tailings will be exposed post-closure. As such, the likelihood for AMD generation from the floor of these voids post-closure would be lower. Should these tailings floors become submerged by groundwater (post-closure), the likelihood for AMD generation from the tailings floor of these voids would be lower.

Geochemical Source-Pathway-Receptor (SPR) Assessment

The source-pathway-receptor (SPR) assessment includes the likelihood of the event occurring (e.g. the likelihood of AMD impacting a local creek), the severity of the event (should it occur) and the calculated risk rating (likelihood times severity). A risk rating was calculated for each spoil landform, each TSF landform, Ramp 36 rejects landform, and each residual void with respect to plausible surface water and groundwater receptors.

Conceptual site model and conceptual facility models

A post-mining conceptual site model (CSM), which applies generically to the spoil landforms and their respective residual voids at BWM, and the broader relationship these facilities have with surface water and groundwater in the district, has been produced by SLR Consulting Australia (SLR, 2026).

The CSM assists with the SPR assessment with regard to potential environmental geochemical impacts from mineral waste facilities. A key element of the CSM based on the SLR (2026) hydrogeological assessment (which included groundwater modelling with particle tracking) was that the residual voids at BWM will be groundwater 'sinks' (i.e. groundwater at BWM will flow into/towards the residual voids, and the voids will be the receptors of seepage from all BWM facilities).

A conceptual facility model (CFM) has been developed for each TSF and for Ramp 36 rejects dump to illustrate potential run-off and seepage pathways and surface water and groundwater receptors associated with these key mineral waste facilities.

Plausible pathways and receptors

Note: the assessment of shallow groundwater at BWM – particularly where shallow permeable strata may be not present in some areas, discontinuous and/or not interconnected – is limited by/to the distribution of the shallow bore network, which is sporadic. Therefore, despite the apparent low likelihood of substantial connection between shallow permeable strata and surface water features, the SPR assessment has adopted a highly conservative approach and assumed a plausible pathway may exist between shallow permeable strata and surface water features. All creeks at BWM are ephemeral. The surface water features (creeks) at BWM that are plausible receptors of run-off and/or seepage are:

- Bonnie Doon Creek west of Ramp 8 and Bonnie Doon spoil landforms, flowing north;

- Burngrove Creek and tributaries west of Mimosa-Besgrove spoil landform, flowing north;
- Deep Creek, flows west to east across the site between Mimosa-Besgrove and Deep Creek spoil landforms;
- Taurus Creek, flows west to east across the site between Deep Creek and Stewarton spoil landforms;
- Emu Creek and its' un-named tributaries, a collective of tributaries located west of Stewarton and Tannyfoil spoil landforms, which flow north into Taurus Creek;
- Sirius Creek, flows generally east to west across the site between Ramp 74 void and Togara-North Marshmead spoil landform. All of the minor un-named creeks on both sides of BWM between Blackdown spoil landform and Ramp 74 void drain into Sirius Creek; and
- Rockland Creek, flows east to west across the site between Togara-North Marshmead and South Marshmead spoil landforms, and northeast to southwest between Comet Downs East and Kennedy spoil landforms.

With regard to the spoil landforms, the plausible mechanisms for AMD affected water and/or non-oxidative salinity, if any, to report to receptors are:

- Surface water run-off from spoil landforms into nearby creeks;
- Seepage from spoil landforms via shallow permeable strata into nearby creeks;
- Seepage from spoil landforms into the residual voids; and
- Surface water run-off and seepage from void highwalls and end-walls into residual voids.

With regard to the TSF and rejects landforms, the plausible mechanisms for AMD affected water and/or non-oxidative salinity, if any, to report to receptors are:

- Surface water run-off from TSF or rejects landforms into nearby creeks;
- Seepage from TSF or rejects landforms via shallow permeable strata into nearby creeks; and
- Seepage from TSF or rejects landforms via groundwater into residual voids.

The SPR has conservatively assumed that shallow permeable strata are a plausible pathway linking a potential AMD source to deeper groundwater via downwards migration and linking a potential AMD source to nearby creeks via lateral migration. However, shallow permeable strata are assumed to be an implausible final receptor of run-off and seepage from final landforms and final voids. That is, the assumption based on information available is that AMD (source) entering shallow permeable strata (however (un)likely) will ultimately find its' way into deeper groundwater [residual voids] and/or local surface water features.

SPR risk rating of rehabilitated spoil landforms

There are plausible surface water and residual void receptors associated with final spoil landforms; and the run-off and seepage pathways linking the sources (final spoil landforms) to these receptors have been identified. With respect to AMD, the overall SPR risk rating from final spoil landforms is **Low**. With respect to non-oxidative salinity the overall SPR risk from final spoil landforms is also rated as **Low**.

Where landforms contain buried tailings and/or rejects, and especially if those buried tailings/rejects are located close to the edge of the landform and/or close to a creek, the risk rating with respect to AMD potentially making its way via shallow permeable strata into surface water features close to the buried tailings/rejects was rated as **Low to Medium**. This applies to Kenmare spoil landform (containing Ramp

72 tailings and Kenmare pit rejects) and Mimosa-Besgrove spoil landform (containing Deep Creek [Ramp 32] rejects dump).

SPR risk rating of rehabilitated NCPP TSF landform

There are plausible surface water and residual void receptors; and the run-off [and shallow seepage] pathways linking the source (NCPP TSF final landform) to these receptors have been identified. Groundwater modelling (SLR, 2026) shows that seepage from NCPP TSF landform would report to Deep Creek residual void. With respect to AMD, the overall SPR risk rating from the post-closure TSF final landform is **Low to Medium**. The 'Medium' risk rating applies to AD and SD associated with seepage via shallow permeable strata potentially impacting Deep Creek. With respect to non-oxidative salinity the overall SPR risk from NCPP TSF final landform is rated as **Low**.

SPR risk rating of rehabilitated Laleham TSF landform

There are plausible surface water and residual void receptors; and the run-off and shallow seepage pathways linking the source (Laleham TSF final landform) to these receptors have been identified. Groundwater modelling (SLR, 2026) shows that post-closure seepage from Laleham TSF landform would ultimately report to Togara-North Marshmead residual void via Ramp 74 void (seepage would likely report to Kenmare residual void via Ramp 74 void prior to long-term post-closure groundwater equilibrium). With respect to AMD, the overall SPR risk rating from the post-closure TSF final landform is **Low**. With respect to non-oxidative salinity the overall SPR risk from Laleham TSF final landform is also rated as **Low**.

SPR risk rating of rehabilitated Bottom Dam TSF and rejects landform

There are plausible surface water receptors; and the run-off and seepage pathways linking the source (Bottom Dam TSF/rejects final landform) to these receptors (Sirius Creek) have been identified. Groundwater modelling (SLR, 2026) shows that seepage from Bottom Dam TSF/rejects area would ultimately report to Togara-North Marshmead residual void via Ramp 74 void (seepage would likely report to Kenmare residual void via Ramp 74 void prior to long-term post-closure groundwater equilibrium). With respect to AMD, the overall SPR risk rating from the post-closure Bottom Dam final landform is **Low**. With respect to non-oxidative salinity the overall SPR risk from the post-closure Bottom Dam final landform is also rated as **Low**.

SPR risk rating of rehabilitated Ramp 36 rejects landform

There are plausible surface water and residual void receptors; and the run-off and shallow seepage pathways linking the source (Ramp 36 rejects final landform) to these receptors (Deep Creek) have been identified. Groundwater modelling (SLR, 2026) shows that seepage from Ramp 36 rejects landform would report to Deep Creek residual void. With respect to AMD, the overall SPR risk rating from the post-closure rejects final landform is **Low to Medium**. The 'Medium' risk rating applies to AD and SD associated with seepage via shallow permeable strata potentially impacting Deep Creek. With respect to non-oxidative salinity the overall SPR risk from the post-closure rejects final landform is also rated as **Low**.

SPR risk rating of residual voids

Modelling undertaken by SLR (2026) shows the final voids to be 'sinks' – receiving surface water run-off and seepage from spoil landforms and surface water run-off from void highwalls and end-walls. Each residual void is expected to receive inflow from the Permian groundwater aquifer.

The AMD assessment has found that it's unlikely that undiluted salinity or AMD from a flooded post-closure residual void floor (including covered tailings) would impact on residual void water quality to any significant degree, as other processes such as evapo-concentration are the key drivers of void lake water quality. Therefore, the AMD SPR risk rating on the overall water quality of the residual voids is **Low to Low-Medium**. A "Low to Medium" risk rating has been conservatively applied to the risk of AD and/or NMD/SD due to the AMD risk associated with tailings within Bonnie Doon and Ramp 74 voids.

Water reporting to residual voids is expected to remain within the voids (excluding evaporative loss). Modelling undertaken by SLR (2026) shows that seepage from the void lake (of each void) into groundwater, if any, would be limited.

Management and Rehabilitation Measures

The assessment has found that the environmental risks posed by spoil landforms likely to be present at closure are generally low. As such – for most spoil landforms – no specific AMD management measures (e.g. alkaline amendment or engineered capping systems) are expected to be required to manage mineral wastes during rehabilitation and closure – outside of operational mixing/burial of PAF waste amongst NAF waste, spoil placement and landform reshaping activities already proposed (refer below and to the main volume of the PRCP).

The AMD source hazard associated with Ramp 72 tailings and Kenmare pit rejects buried within Kenmare landform is high and, as such, rehabilitation of tailings and rejects within Kenmare ramp/pit will require specific AMD management measures – and the assessment program currently underway at Kenmare pit will address the rehabilitation requirements of these facilities. Once rehabilitated, the post-closure environmental risk posed by Kenmare spoil landform is expected to decrease.

The landform domain AMD hazard posed by NCPP TSF, Laleham TSF, Bottom Dam TSF and Ramp 36 rejects dump is moderate-high. These stand-alone landforms will require specific AMD management measures to manage these facilities post-closure.

The AMD hazard posed by tailings in Bonnie Doon in-pit TSF is moderate-high; and for tailings in Ramp 74 in-pit TSF is moderate. As such, in-pit tailings will also require specific AMD management measures to manage these voids post-closure.

Decommissioning and rehabilitation activities related to mineral waste will be addressed as part of the milestone criteria for infrastructure, remediation of contaminated land, landform design, surface preparation and revegetation, where necessary.

Proposed mineral waste management and rehabilitation activities of relevance to this waste characterisation report comprise the following actions. Refer to the main volume of the PRCP and Henderson Geotech (2024) for detailed information.

- Pits: will remain as residual voids under 15 groups (voids) as identified previously.
- Spoil dumps: will be reshaped into 14 final spoil landforms – mostly as related to their respective voids listed. Stewarton pit will be mined into two voids (Stewarton North and Stewarton South). Blackdown pit will be backfilled, leaving Blackdown spoil landform without an associated residual void. Spoil from Ramp 30S pit will form part of Mimosa-Besgrove spoil landform. After reshaping, all spoil dumps will be seeded.
- Bonnie Doon in-pit TSF will be covered by a spoil and water cover (hybrid cover). The optimal type and thickness of cover to manage the AMD hazard of Bonnie Doon in-pit TSF (tailings) will be determined following further assessment prior to covering.

- Ramp 74 in-pit TSF will be covered by a spoil and water cover (hybrid cover). The optimal design and thickness of cover to manage the AMD hazard of Ramp 74 in-pit TSF (tailings) will be determined following further assessment prior to covering.
- NCPP TSF (out-of-pit; above ground; stand-alone) will be covered by an engineered spoil cover. The optimal design and thickness of spoil cover to manage the AMD hazard of the out-of-pit NCPP TSF will be determined following further assessment prior to covering.
- Laleham TSF (in-pit; above ground; stand-alone) will be covered by spoil. The optimal design and thickness of spoil cover to manage the AMD hazard of the TSF will be determined following further assessment prior to covering.
- Ramp 72 in-pit TSF will be covered by spoil within Kenmare spoil landform. The optimal design and thickness of spoil cover to manage the AMD hazard of the in-pit TSF will be determined following further assessment prior to covering.
- Bottom Dam TSF/rejects (out-of-pit; above ground; stand-alone). Rejects currently on ROM 3 will be relocated onto Bottom Dam TSF forming a rejects cap, which will then be covered by a spoil cover. The optimal design and thickness of spoil cover to manage the AMD hazard of Bottom Dam TSF/rejects area will be determined following further assessment prior to covering.
- Kenmare in-pit rejects will be covered by spoil within Kenmare spoil landform. The optimal design and thickness of spoil cover to manage the AMD hazard of these in-pit rejects will be determined following further assessment prior to covering.
- Ramp 36 rejects (above ground; stand-alone) will be covered by a spoil cover. The optimal design and thickness of spoil cover to manage the AMD hazard of the rejects dump will be determined following further assessment prior to covering.
- All other rejects (in-spoil disposal): Managed during operations (disposed within spoil) and progressively covered by spoil. No additional remediation for the rejects (at closure) is required. The optimal thickness of spoil cover to manage the AMD hazard of rejects will be determined following further assessment prior to covering.
- ROM pads: Remove remnant coal from ROM pads and dispose within spoil. All former ROM pads will be reshaped, covered with soil, ripped and seeded.
- Coal stockpiles: Remove remnant coal from coal stockpile pads and dispose within spoil. Cover with suitable soil material, rip and seed.

Blackwater Mine

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GLOSSARY of TERMS

ABA	Acid-base account. Evaluation of the balance between acid generation and acid neutralisation processes. Generally determined by the maximum potential acidity (MPA) and the inherent acid neutralising capacity (ANC), as defined below. See also ANC and MPA.
Acid	A measure of hydrogen ion (H^+) concentration in water; generally expressed as pH.
Acidity	A measure of hydrogen concentration and latent acidity generated by metal hydroxylation, expressed as mg/L.
AMD	Acid and metalliferous drainage. AMD has three components: acid drainage (AD), pH-neutral and metalliferous drainage (NMD) and/or sulfide-derived saline drainage (SD) – and/or any combination of these, all generated by sulfide oxidation processes +/- neutralisation reactions.
ANC	Acid neutralising capacity, expressed as kg H_2SO_4 per tonne of rock/material. A measure of a sample's maximum potential ability to neutralise acid.
ANC/MPA ratio	Ratio of the acid neutralising capacity (ANC) to the maximum potential acidity (MPA) of a sample. Used to assess the risk of a sample generating acid conditions. See also ANC and MPA.
BWM	Blackwater mine. The name of the site subject to this PRCP.
CFM	Conceptual facility model.
CHPP	Coal handling and preparation plant. BWM has three CHPPs: the current (operational) CHPP, called NCPP, which is located near the BWM industrial area; a small thermal coal plant called TCP; and a disused (historic) CHPP called SCPP, which is located at the southern part of BWM [in the area referred to as South BWM].
Co-Disposal	The practice of disposing different waste types together. For example, disposing rejects and spoil together.
CSM	Conceptual site model.
EC	Electrical conductivity, expressed as μS/cm.
Interburden	Potential spoil material located between mined coal seams. See also Overburden, Mineral waste and Spoil.
Kinetic test	Procedure used to measure the geochemical/weathering behaviour of a sample of mine material over time.
Mineral waste	Material comprising mine spoil, ± coarse/fine reject, ± waste coal. Sometimes called 'mine waste' or 'mining waste'.
MPA	Maximum potential acidity. Calculated by multiplying the total sulfur (S) or sulfide-sulfur (Scr) content of a sample by 30.6 (stoichiometric factor) and expressed as kg H_2SO_4 per tonne of rock/material.
NAF	Non-acid forming. Geochemical classification criterion for a sample that would not generate acid conditions. A sample classified as NAF may, or may not, have a significant sulfur content but the availability of neutralising material within the sample is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulfide minerals. As such, material classified as NAF is considered unlikely to be a source of acid(ic) drainage, however NAF material may still develop NMD and/or SD, depending on sulfur concentration.

NAG	Net acid generating test. A pulp sample is reacted with hydrogen peroxide to encourage rapid oxidation. Any acid generated through oxidation may be consumed by neutralising components in the sample. Any remaining acidity (after neutralising material is consumed) is measured and expressed as kg H_2SO_4/t. At the conclusion of the NAG test the resulting liquor is called peroxide (NAG) leachate, and can be analysed for various parameters, such as soluble metals.
NAPP	Net acid producing potential, expressed as kg H_2SO_4 per tonne of rock/material. Calculated by subtracting the ANC from the MPA.
NCPP	North coal handling and preparation plant; the current (operational) CHPP located near the BWM industrial area.
NMD	Neutral and metalliferous drainage. A component of AMD, NMD occurs where drainage is pH-neutral or higher yet contains elevated trace metals and metalloids in solution.
Org S	Organic sulfur.
Overburden	Mineral (mining) waste located above (overburden proper) or between (interburden) coal seams and reports to spoil dumps. Typically comprises non-coaly and non-carbonaceous material, such as sandstone, siltstone and claystone/mudstone, but also includes a small percentage of carbonaceous material (e.g. carbonaceous siltstone) and sub-economic waste coal.
OxCon	Oxygen consumption test. A type of kinetic (dynamic) test for estimating the sulfide oxidation rates, acidity generation rates and carbonate neutralisation rates for sulfidic geological materials.
PAF	Potentially acid forming. Geochemical classification criterion for a sample that has the potential to generate acid conditions. A sample classified as PAF has an acid generating potential (MPA) that exceeds the inherent acid neutralising capacity (ANC) of the material. This means that such a material is likely to generate acidic drainage (AD) if exposed to atmospheric conditions. See also PAF-LC.
PAF-LC	Potentially acid forming (low capacity). Geochemical classification criterion for a sample that has the potential to generate relatively low-level AD.
PRCP	Progressive rehabilitation and closure plan.
Product coal	Coal produced from the CHPP after being washed/processed. Coal that is ready for sale.
Rejects	Coarse sand to coarse gravel-sized rock material produced during coal processing. Rejects are typically associated with the roof, floor and partings of coal seams and are separated from ROM coal in the CHPP. Contemporary rejects produced at BWM are disposed within spoil dumps in the general vicinity of the NCPP. Historic rejects have been disposed into rejects dumps (stockpiles) and within disused pits. Rejects have also been used in construction activities, such as TSF embankments and used for capping/construction of pads.
Rejects dump	Out-of-pit landform containing rejects.
Residual void	The term given to an open-pit after mining has ceased and any rehabilitation of the pit has been undertaken (i.e. post-closure).
ROM	Run-of-mine. The term given to mined coal before being processed at the CHPP.
ROM pad	Location where ROM ore is temporarily stored pending processing at the CHPP.
S	Sulfur.

SCPP	South coal handling and preparation plant; a disused (historic) CHPP located at the southern part of BWM [in the area referred to as South BWM].
Scr	Chromium reducible sulfur. Analytical procedure to determine the sulfide-sulfur concentration in a sample. This typically represents the proportion of sulfur associated with sulfide (reactive) minerals.
SD	Saline drainage. A component of AMD, SD occurs where drainage is saline due to elevated sulfate as a result of sulfide oxidation and neutralisation reactions.
SO_4	Sulfate.
Spoil	Rock material overlying and between 'target' coal seams, which will report as waste. Waste rock overlying a coal seam is called overburden. Waste rock between mined coal seams is called interburden. See also Overburden and Interburden.
Spoil dump	In-pit or out-of-pit landform containing mineral waste.
SPR	Source-pathway-receptor.
Static test	Procedure for characterising the geochemical nature of a sample at one point in time. Static tests may include measurements of mineral and chemical composition of a sample and the Acid-Base Account.
Tailings	Very fine to medium grained sand, silt and clay-sized material, which is commonly coaly and carbonaceous, produced during coal washing. Tailings are associated with coal seams and are separated from ROM coal in the CHPP. Tailings produced at BWM are disposed within Tailings Storage Facilities (TSFs – also called tailings dams).
TCP	Thermal coal plant.
TSF	Tailings storage facility. A dam or pit used to dispose tailings. At BWM, tailings have been disposed into several above-ground and in-pit TSFs – the current (operational) TSF being Bonnie Doon in-pit TSF.
Uncertain	In the context of classifying a material (sample) as NAF or PAF. An 'Uncertain' (UC) classification applies when there is an apparent conflict in results such that neither NAF nor PAF classification can be given, or there is insufficient information to unequivocally classify as NAF or PAF. UC samples are given a tentative sub-classification as UC(NAF) or UC(PAF), where preliminary data suggests the sample may be NAF or PAF, respectively.
Waste coal	Sub-economical coal that reports directly to the spoil dumps as waste (i.e. not ROM coal). Waste coal can be fresh or weathered (oxidised). All weathered/oxidised and coked (cindered) coal is waste.
Water extract	A method to determine the water-soluble parameters in soil. Solid samples undergo a bottle leach method where 10 g of pulped solid (100% passing 212 μm) is combined with 50 grams of de-ionised water (leaching fluid) into a glass bottle. Depending on the type of leaching undertaken the leaching fluid may be deionised water (DI water extract) or saline water (saline water extract). The 1:5 solution (1 part solid to 5 parts water) is tumbled end-over-end for one hour. Solutes are leached from the soil by the continuous suspension and agitation. The water extract solution is measured for pH and electrical conductivity (EC) prior to filtering for solute analysis (e.g. metals/metalloids and major ions).

1 Introduction and Context

This report serves to document and discuss the environmental geochemical characteristics of mineral waste materials associated with Blackwater Mine (BWM), as defined under the current Environmental Authority (EA) EPML00717813. BWM is operated by Whitehaven Blackwater Pty Ltd. In this report the term 'mineral waste' refers to all geologic material generated by or associated with BWM during the course of mining, handling and processing coal.

It is a requirement of a Progressive Rehabilitation and Closure Plan (PRCP) that mineral waste is adequately characterised such that appropriate rehabilitation strategies can be selected and implemented. The PRCP guidance document: "Statutory g*uideline - Progressive rehabilitation and closure plan (PRC plans)*" (DESI, 2024) outlines the requirements and considerations for producing a PRCP, including documenting the relevant aspects of mineral waste characterisation for the purposes of PRCPs.

1.1 Approach

The general approach to mineral waste characterisation and assessment includes the following key steps:

- Briefly describe the current/existing background information for BWM of relevance to the generation and ultimate storage/disposal of mineral waste materials;
- Document the methodology used to characterise mineral waste materials (samples);
- Present and discuss the geochemical results;
- Describe the potential environmental geochemical hazards with respect to mineral waste materials;
- Present the conceptual site model (CSM), which illustrates the relationship between AMD and salinity sources, potential environmental and human health receptors and plausible pathways between the AMD and salinity sources and the receptors (Source-Pathway-Receptor [SPR]) at closure;
- Present the acid and metalliferous drainage (AMD) and salinity SPR risk assessment undertaken on the mineral waste materials;
- Outline the AMD specific management and rehabilitation measures proposed for mineral waste materials; and
- Outline a forward work plan to address any gaps identified from the assessment.

1.2 Objective

The objective of the assessment is to evaluate the geochemical nature of mineral waste currently at BWM and mineral waste likely to be present at closure, and identify relevant environmental issues/opportunities that may be associated with mining, handling and storing mineral waste to inform appropriate rehabilitation and management strategies.

2 Background

2.1 Site Overview

BWM is located within the Bowen Basin in Central Queensland. The administration and industrial areas are located approximately 75 kilometres (km) southeast of Emerald township. The northern end of the mine at Bonnie Doon pit is about 5 km southwest of Blackwater township. BWM is flanked on the east, west and south by pastoral leases; and bounded to the north by the Capricorn Highway. BWM is a very large mine with a strike length of approximately 65 km and is informally divided into two mining areas: north and south, based on historical ownership. The northern area of BWM is the current mining area - from Bonnie Doon pit south to Blackdown pit. The southern area includes existing (currently inactive) pits from South Ballamoo pit (also known as Terang pit) southwards to North Marshmead pit, plus proposed pit areas at South Marshmead, Kennedy and Comet Downs East.

BWM commenced operations in 1967 and comprises typical open-pit coal mining facilities, such as open pits, waste rock (spoil) dumps, tailings storage facilities (TSFs), rejects dumps, coal stockpiles, coal processing facilities, rail loadout facilities, process water and raw water dams, surface water drains and administration areas. There are also closed/inactive underground workings in the southern area of BWM. The key facilities and natural features at BWM of relevance to this waste characterisation report are shown on **Figure 1** (northern part of the mine) and **Figure 2** (southern part of the mine). [Also shown on Figures 1 and 2 are geochemical sampling locations and the locations of geological sections along and across each existing pit group and proposed new pit groups].

Current activities of relevance to this waste characterisation report comprise:

- Disposal of spoil to in-pit spoil dumps behind the active mining face (in-pit low-wall spoil disposal);
- Run-of-mine (ROM) coal processing at the north coal handling and preparation plant (NCPP), which produces two mineral waste types:
    - Tailings. Clay, silt and very fine to medium-grain sized sand material; disposed as a slurry.
    - Rejects. Coarse sand to cobble-sized material.
- Thermal ROM coal processing at the thermal coal plant (TCP), which produces a small amount of rejects.
- Disposal of tailings from NCPP to Bonnie Doon pit (Ramp 12 in-pit TSF); [active since late 2023];
- Disposal of rejects from NCPP and TCP to spoil dumps; Rejects from NCPP have been used in construction of TSF embankments and infrastructure pads;
- Short-term storage of ROM coal on the ROM Pad and product coal on the product coal stockpile.

Historic activities of relevance to this waste characterisation report comprise:

- Disposal of tailings from NCPP to the above-ground NCPP TSF; [inactive since late 2023];
- Disposal of rejects from NCPP and TCP to rejects dumps (primarily Ramp 36 and TCP rejects dump);
- ROM coal processing at the south coal handling and preparation plant (SCPP), which produced tailings and rejects similar to NCPP. The SCPP received ROM coal from open cut and underground mining operations in the southern BWM area (what was then called South BWM). SCPP has been inactive since the early 2000s.

- Disposal of tailings from SCPP to the above-ground Laleham TSF, two in-pit TSFs (Kenmare pit - Ramp 72 TSF; and Ramp 74 pit - Ramp 74 TSF) and Bottom Dam TSF (gully southeast of the SCPP ROM 3 pad). Tailings from NCPP were also disposed into Ramp 74 TSF;
- Disposal (rehandling) of mixed 'aged' tailings and rejects (originally from SCPP) into the southern end of Kenmare pit (Ramp 72 pit);
- Disposal of rejects from SCPP onto ROM Pad 3 and into Bottom Dam area adjacent to Bottom Dam TSF.

An overview of the proposed mineral waste management and rehabilitation activities of relevance to this waste characterisation report are outlined in **Section 8**. Refer to the main volume of the PRCP for detailed information.

Figure 1. Project layout, geochemical sample locations and locations of geological sections for the northern BWM area

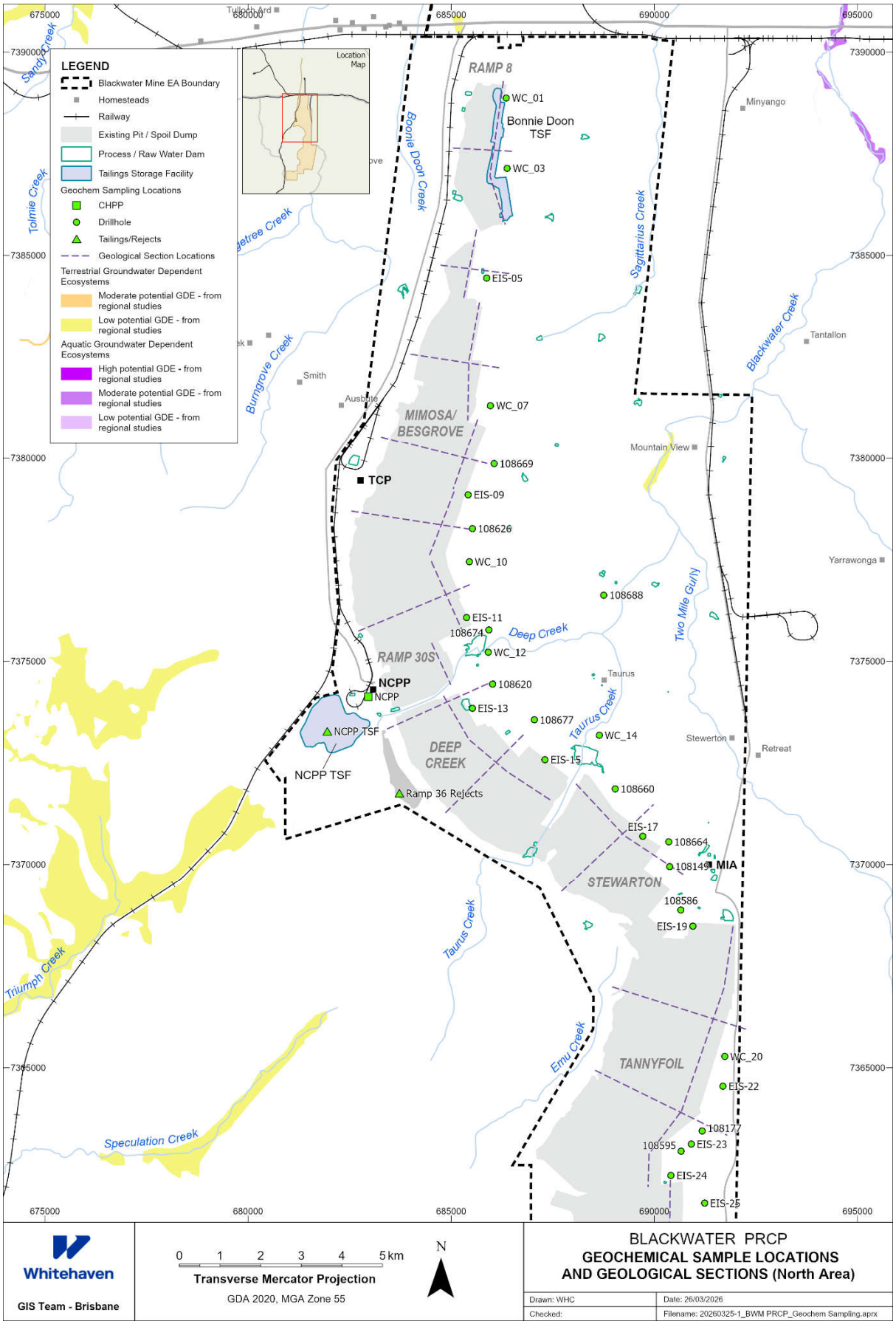
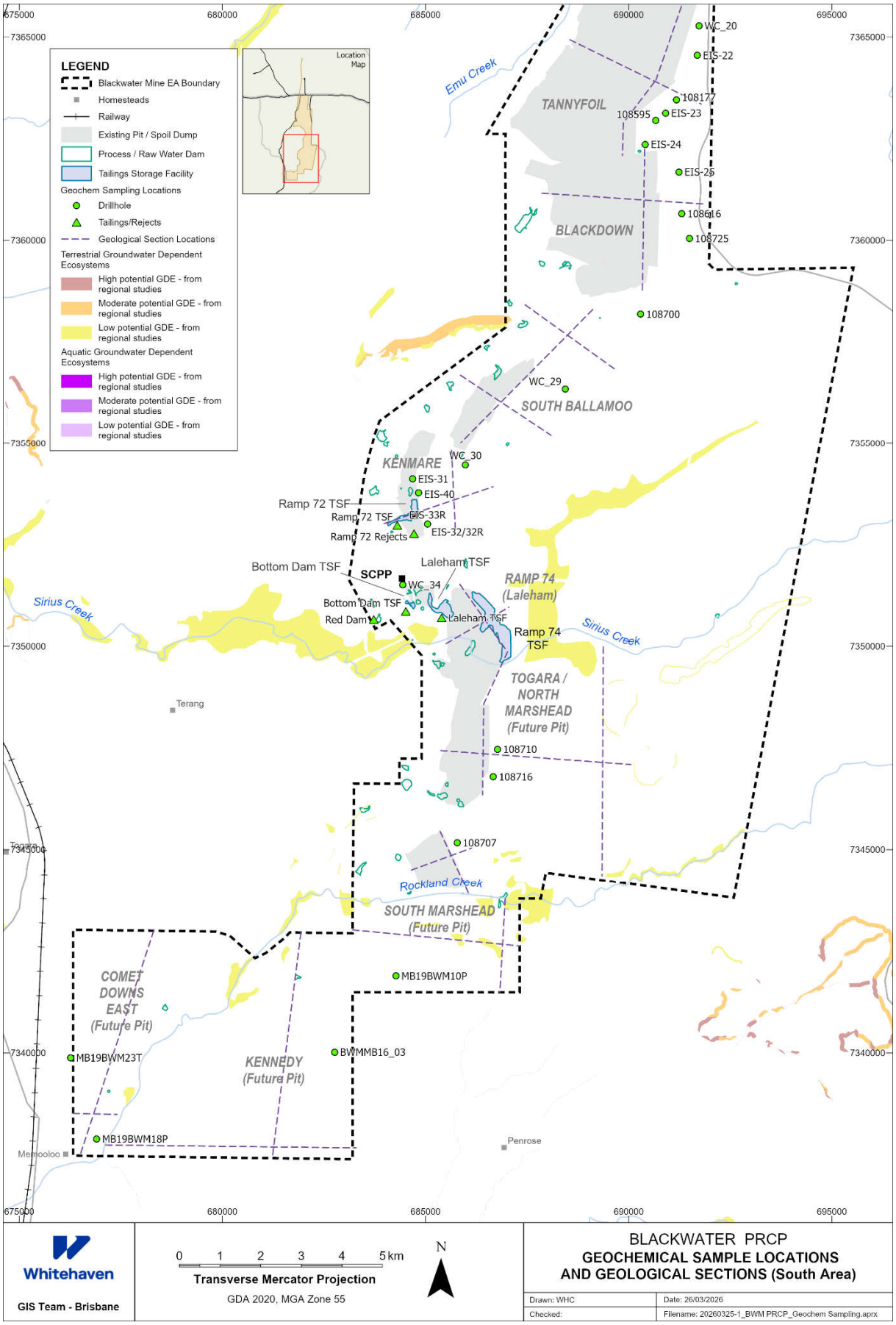


Figure 2. Project layout, geochemical sample locations and locations of geological sections for the southern BWM area



2.2 Mine Domains

The mine domains of direct relevance to mineral waste management at BWM at closure are:

- Spoil landforms and their corresponding residual voids (spoil dumps and/or pits remaining at end of mine life):
    - Ramp 8 spoil landform and residual void;
    - Bonnie Doon spoil landform and residual void, which will include Bonnie Doon TSF within the void;
    - Mimosa-Besgrove spoil landform and residual void, plus Ramp 30S residual void;
    - Deep Creek spoil landform and residual void;
    - Stewarton North spoil landform and residual void;
    - Stewarton South spoil landform and residual void;
    - Tannyfoil spoil landform and residual void;
    - Blackdown spoil landform. Blackdown pit will be backfilled (i.e. no Blackdown residual void);
    - South Ballamoo spoil landform (previously/historically called Terang) and residual void;
    - Kenmare spoil landform and residual void, which will include Ramp 72 TSF within the landform;
    - Ramp 74 spoil landform and residual void, which will include Laleham TSF within the northern edge of the Ramp 74 spoil landform and Ramp 74 TSF within Ramp 74 void;
    - Togara-North Marshmead spoil landform and residual void;
    - South Marshmead spoil landform and residual void;
    - Kennedy spoil landform and residual void; and
    - Comet Downs East spoil landform and residual void.

  Bonnie Doon TSF (the current/active TSF within Bonnie Doon pit) and Ramp 74 TSF (Ramp 74 pit) will remain within their respective residual voids. Ramp 72 TSF (within current Kenmare pit) will be buried by spoil during rehabilitation and will be incorporated by the Kenmare spoil landform.

  Note: most of the spoil landforms are not 'discrete' (completely stand-alone) features. Instead, they should be thought of as zones within a single landform with a hummocky, rolling topography - higher spoil areas behind (west of) each residual void, where mining occurred - and lower between voids, where pit ramps were located.

- TSF landforms:
    - NCPP TSF (inactive; above-ground facility);
    - Laleham TSF (inactive/decommissioned and partially rehabilitated; above-ground facility); and
    - Bottom Dam TSF (inactive/decommissioned; above-ground facility).
- Rejects landforms:
    - Ramp 36 rejects landform near Deep Creek (inactive/decommissioned; above-ground facility).
- TCP rejects will be relocated into the Mimosa-Besgrove spoil landform during rehabilitation of the TCP area and, as such, will not remain as a rejects landform post-closure.
- Coal stockpiles: ROM coal pad and stockpile; and Product coal pad and stockpile.

Material types and quantities

BWM has three main types of mineral waste, and the geochemical characteristics and potential hazards associated with mineral waste materials on site are discussed by type:

- Spoil (overburden and interburden) currently comprises approximately 99% of all mineral waste at BWM and includes weathered waste (Tertiary and Permian-age) and fresh (unweathered) waste (all Permian-age). On average, approximately 40% of spoil is weathered/oxidised and the remaining (approximately 60%) is fresh, with the proportion of weathered to fresh spoil varying throughout the site. In the northern half of the site the proportion of weathered to fresh spoil is about 25% weathered to 75% fresh, whereas in the southern half of the site the proportion of weathered to fresh spoil is about 49% weathered to 51% fresh.
- Tailings are generated at the NCPP (and previously also at the SCPP) from processing ROM coal and typically represent the clay, silt and fine sand fractions of ROM waste. Throughout operations at BWM, tailings have been disposed as a slurry into a number of TSFs – the current (active) TSF being Bonnie Doon in-pit TSF. Tailings comprises approximately 0.5% of all mineral waste at BWM – with this approximated proportion expected for the remaining life of asset mine plan.

Rejects are generated at the NCPP (and previously also at the SCPP) from processing ROM coal and typically represents coarser and rockier seam roof, partings and floor material. Rejects are trucked to several locations for disposal into spoil. Historically, rejects were also disposed onto rejects dumps, such as Ramp 36 rejects dump, TCP rejects dump and Bottom Dam TSF [mixed tailings and rejects]. Some rejects have been used in construction of TSF embankments and infrastructure pads (e.g. ROM and coal stockpile pads). Rejects comprise approximately 0.5% of all mineral waste at BWM – with this approximated proportion expected for the remaining life of asset mine plan.

Coal is also included in the assessment; however, coal is generally not considered mineral waste, with the exception of small quantities of sub-economic seams that may report to the spoil dumps, and remnant coal exposed on pit highwalls and end-walls (such as in residual voids).

2.3 Baseline Information

2.3.1 Topography

The most prominent topographic feature in the region is the Blackdown Tablelands (also known as the Blackdown Ranges) – a sandstone plateau situated about 10 km to the east of BWM mine, which rises abruptly from the surrounding plains to an elevation of approximately 900 metres Australian Height Datum (mAHD), however most of the Tablelands have an elevation of around 340 to 400 mAHD. The relatively steep slopes associated with the Blackdown Tablelands contrast with the generally lower relief areas west of the ranges at BWM, particularly throughout the northern half of the site.

Throughout the northern part of BWM the elevation is typically between 180 to 220 mAHD. Comparatively, the southern and southwestern area has much greater topographic relief, ranging from approximately 170 mAHD in the southwest of the PRCP area in the vicinity of Comet Downs East to approximately 390 mAHD at the eastern ML boundary between Blackdown and Terang pits (average approximately 300 mAHD for the southern area).

2.3.2 Climate

The following information about climate is general and provided for broad context. Refer to the main volume of the PRCP for detailed information about climate at BWM.

BWM is located within Queensland's semi-arid climatic zone, which is characterised by high summer temperatures, warm dry winters and generally distinct wet and dry seasons; with higher rainfall and higher evaporation occurring over the summer months (December to February).

Climate data is available from Bureau of Meteorology weather stations near Blackwater township [Blackwater water treatment plant (station ID 035290) and Blackwater airport (station ID 035134)], and from Emerald airport (station ID 035264) located about 70 km west of BWM.

Average maximum temperatures range from approximately 23°C in June/July to 34°C in December/January, with average minimum temperatures ranging from approximately 9°C in June/July to 22°C in January.

Average annual rainfall is approximately 547 mm at Blackwater township and about 561 mm at Emerald. Average annual evaporation is approximately 2000 mm for the district. As would be expected for the region, the evaporation rate is highest in the summer months (December/January) and lowest in the cooler months (June/July).

Rainfall events are often associated with thunderstorms, which are typically short-lived, intense and have variable coverage. Sustained rainfall over a large landscape area is experienced when tropical lows with cyclonic activity occur in coastal area. However, periods of prolonged drought do occur within the region.

2.3.3 Geology

The Blackwater sits on the eastern flanks of the Comet Ridge, a major regional anticline. Throughout most of BWM the sediments strike north-south and dip gently towards the east with average bedding dips of 3-5 degrees (although there are significantly steeper areas associated with faulting). In the far southern area the strike direction is west-east. The lithology at BWM is characterised by typical basin-fill sediments, comprising mudstone, claystone, siltstone, sandstone (typically fine- to medium-grained), carbonaceous sediments and coal seams.

In coal environments (i.e. at coal mines) fresh carbonaceous materials typically have higher sulfide concentrations compared with fresh non-carbonaceous materials and, as such, typically pose a greater environmental geochemical hazard compared with fresh non-carbonaceous material. Comparatively, non-carbonaceous lithologies are essentially void of (or have negligible) carbonaceous material and thus have low or nil sulfide mineral concentration. The key exception is that non-carbonaceous materials located within coal seams or immediately above and below (within, say, 0.5m of) coal seams tend to have a higher sulfide concentration compared to bulk overburden/interburden located away from seams.

Minor basalt is encountered within Tertiary-age material. Excluding the far southern area that has not been mined (and is subject to development approval), the depth to base of weathering averages about 23 m below natural surface throughout but ranges from about 10 m to 60 m below natural surface, depending on the local topography. Depth to base of weathering is generally highest in the far southern area (not currently mined), with an average depth to base of weathering of about 45 m below natural surface.

The economic coal seams in the Blackwater area are contained within the late Permian-age Rangal Coal Measures. The Rangal Coal Measures are underlain by the Burngrove Formation (which outcrops west of the site) and are overlain by the Early Triassic-age Rewan Formation. In some areas at the southern end of the mine the Rangal Coal Measures are unconformably overlain by up to 45 m of partially consolidated Cainozoic (Tertiary) sands, gravels, basalts and clays. Elsewhere on the mine, Tertiary cover

is usually much thinner. Most areas on the mine are also capped by thin veneer of Quaternary-age sediments (typically alluvial sediments).

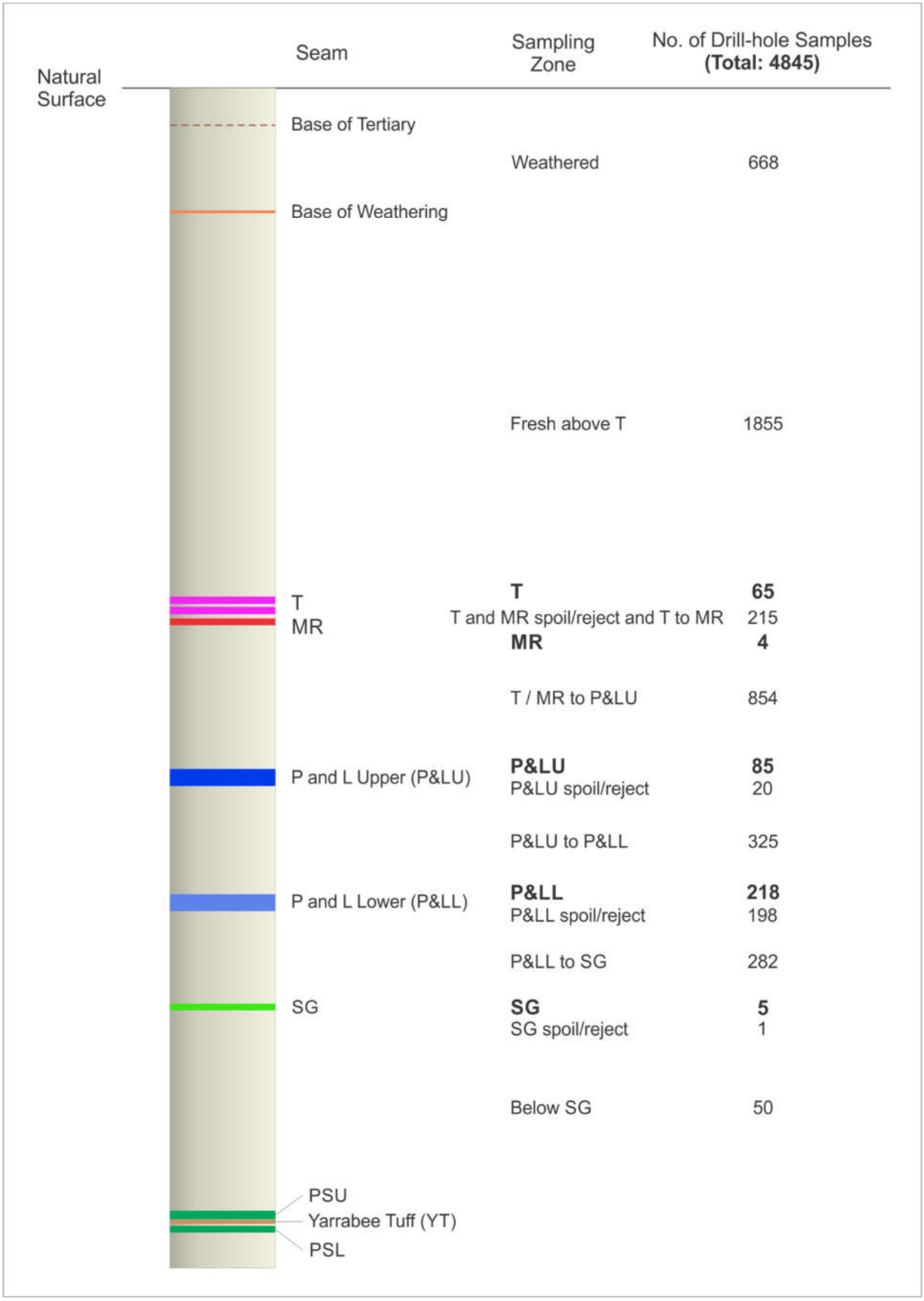
Blackwater mine currently exposes three principal seam groups from the Rangal Coal Measures – called the tops, middles and lowers [historically, the southern BWM area (what was once called South BWM) named these seam groups Aries (tops), Castor (middles), Pollux/Orion/Argo (lowers)]. The northern end of the mine predominately mines the lower seam group, whereas the central and southern areas mine all three seam groups. The seams split and re-join through the mine often creating upper and lower sub-sections of itself, typically called riders (e.g. Top Rider, Middle Rider).

An indicative stratigraphic column showing the seam groups is provided in **Figure 3**, which also includes the number of geochemical samples collected from each overburden and interburden zone, and also from within each seam group (refer to **Section 4.3** for information regarding sample collection). The intention of the stratigraphic column is not to show each specific sub-seam and ply, but rather to provide an indication of the availability of environmental geochemical information throughout the general stratigraphic sequence from natural surface down to approximate pit depth.

Geological long-sections along (or close to) the current highwall of the existing pits and the expected void highwalls of the proposed pits are provided at **Appendix A – Figures A1 to A7**. Geological cross-sections through the existing pits and proposed pit areas (including current topography) are provided at **Appendix A – Figures A8 to A14**. Refer to **Figures 1 and 2** for section locations. The seam groups are shown in the geological sections.

Due to the generally eastward dip of the seams (southward dip in the three southern-most pits) and the nature of the seams splitting and coalescing, the location of the weathered zone shown in the stratigraphic column (**Figure 3**) varies from pit to pit (north to south) and also from west (start of mining) to east (current and future mining). Refer to the geological long- and cross-sections in **Appendix A**.

Figure 3. Indicative stratigraphic column



2.3.4 Surface water / hydrology

The following information about surface water / hydrology is general and provided for broad context. Refer to the main volume of the PRCP for detailed information about surface water at BWM.

A topographic divide runs across the site approximately between Blackdown and South Ballamoo (Terang) pits, separating the mine into two distinct drainage catchments – a northern catchment area that drains east and north primarily to Blackwater Creek (and northwest via Burngrove Creek), and a southern area that predominantly flows south and west via Sirius Creek and Rockland Creek.

The surface drainage at BWM comprises a number of named and un-named ephemeral creeks that are tributaries of Blackwater Creek, Sirius Creek and Rockland Creek. To the north of the topographic divide the drainage direction is from south to north ultimately into the Mackenzie River, which is the main surface drainage in the region. To the south of the divide, creeks generally flow from north-east to south-west and then westward into the Comet River, which then drains into the Nogoa/McKenzie Rivers near the township of Comet, approximately 35 km west of Blackwater township.

All watercourses and tributaries within and in the vicinity of BWM are highly ephemeral and only flow briefly after rainfall. The creeks at BWM, from north to south, are shown on **Figures 1 and 2** and include:

Northern catchment creeks

- Burngrove Creek, flowing northwest from the Mimosa and Sagittarius pit area. All of the small un-named creeks west of Mimosa-Besgrove spoil landform drain north into Burngrove Creek (a tributary of McKenzie River);
- Various un-named creeks located in the highwall area between Bonnie-Doon pit and Sagittarius pit, which flow east and northeast into Sagittarius Creek (a tributary of Blackwater Creek);
- Various un-named creeks located in the highwall area between Burngrove pit and Besgrove pit, which flow east into Taurus Creek (a tributary of Blackwater Creek);
- Deep Creek, which flows west to east across the site between Besgrove/R30S and Deep Creek pits. Near the eastern ML boundary, Deep Creek flows into Taurus Creek (a tributary of Blackwater Creek). Small un-named creeks on the southern side of NCPP TSF (west of Deep Creek Rejects area) drain into Deep Creek;
- Taurus Creek, which flows west to east across the site between Deep Creek and Stewarton North pits. Most of the small un-named creeks on the south-western side of Deep Creek pit drain into Taurus Creek;
- Emu Creek and its' un-named tributaries, a collective of minor tributaries located west of Stewarton and Tannyfoil pits, which flow north into Taurus Creek; and
- Various un-named creeks located in the highwall area between Stewarton, Tannyfoil and Blackdown pits, which flow north into Two Mile Gully (a tributary of Taurus Creek).

Southern catchment creeks

- Sirius Creek, which flows generally east to west across the site near Ramp 74 pit. All of the minor un-named creeks on both sides of the mine between Blackdown pit and Ramp 74 pit drain into Sirius Creek; and

- Rockland Creek, which flows generally northeast to southwest across the site between Togara-North Marshmead and South Marshmead pits and between Comet Downs East and Kennedy pits.

Of the above creeks, Burngrove Creek, Deep Creek and Taurus Creek in the northern catchment and Sirius Creek and Rockland Creek in the southern catchment are the most significant watercourses within and surrounding BWM. All other minor and un-named tributaries flow into one of these five key watercourses.

2.3.5 Groundwater / hydrogeology

The following information about groundwater / hydrogeology is general and provided for broad context. Refer to the main volume of the PRCP for detailed information about groundwater at BWM.

An aquifer is defined as a groundwater bearing formation sufficiently permeable to transmit and yield water in usable quantities. The Quaternary alluvial formations, Tertiary sediment and basalt formations, Rewan Group (Triassic age) and the Permian coal measures generally yield low sustainable volumes of poor-quality water. As such, these formations are not recognised as 'true' aquifers in the area. However, for the purpose of the discussion, groundwater-bearing zones at BWM are referred to as aquifers. The hydrogeological units at BWM are outlined in **Table 1**.

Table 1. Hydrogeological units

Age	Geological Unit	Aquifer
Quaternary	Undifferentiated alluvium (mainly clay, silt, sand and gravels) associated with floodplains of the major drainage channels	Sand and gravel deposits within the alluvium forming unconfined aquifer; Predominantly localised in pockets close to creeks (i.e. not a continuous aquifer), therefore often dry during dry periods.
Tertiary & Triassic	Regolith: Undifferentiated colluvium and weathered units (clay, silt, sand, and weathered mudstone/siltstone/ sandstone. Basalt also present in the southern part of the site	Unconfined and largely unsaturated unit. Insignificant groundwater host.
Triassic	Rewan Group: Mudstones interbedded with siltstones and fine- to medium-grained sandstone.	Regional-scale aquitard (very low yielding)
Permian	Rangal Coal Measures: [overburden and interburden]. Mainly sandstone, siltstone and claystone	The low-permeability sandstone and siltstone interburden units (between coal seams) are typically dry or very low yielding (i.e. have aquitard properties).
	Rangal Coal Measures: [coal seams]	The coal seams are identified as the primary aquifer; associated with secondary porosity through coal seam cleats/cracks and fissures/fractures associated with faults intersecting coal seams. The coal measures are highly faulted, resulting in groundwater compartmentalisation. Recharge is via direct infiltration where seams outcrop or sub-crop.
	Burngrove Formation: mudstone, siltstone, sandstone, coal and tuff. Equivalent to the Foot Cooper Coal Measures elsewhere in the Bowen Basin.	Coal seams of this unit form a regional-scale aquifer in conjunction with low permeability overburden and interburden, that essentially form aquitards. Considered the 'basement' formation at BWM.

The main factors influencing natural groundwater levels are groundwater recharge, evapotranspiration and regional flow patterns. Due to the heterogeneity and discontinuity (and often dry condition) of the Quaternary alluvium aquifers and Tertiary sediment and basalt units, the groundwater flow direction in these 'aquifers' cannot be determined on a regional scale – and is likely to be very local and topographically controlled, flowing from higher elevations to lower elevations – particularly in the southern half of BWM where there is greater topographic relief. Regionally, the groundwater flow direction within the Permian coal seams generally mimics the surface water flow direction. Prior to mining, groundwater flow in the northern half of BWM would have been generally towards the north and groundwater flow in the southern half of BWM would have been generally towards the southwest. Locally, these groundwater flow directions have been interrupted by mining, with current groundwater flow directions in the vicinity of the mine being towards the pits (i.e. the pits are currently groundwater 'sinks'). Information available suggests the presence of impermeable faults at some locations have hydraulically compartmentalised the coal seams in these faulted areas. It is noted that Cook Underground Colliery (not part of BWM) located immediately east of BWM near Tannyfoil residual void is likely a localised groundwater 'sink'.

Potential for groundwater-surface water interaction

Based on hydrogeological studies and conceptualisation of groundwater flow (refer to groundwater section of the PRCP), groundwater interaction with ephemeral creeks is considered to be unlikely – with the exception of Sirius Creek in the southern area of the mine. The extent of alluvium is limited, both horizontally and vertically, suggesting dry conditions for most of that unit and water tables significantly below the creek beds. The regolith (i.e. weathered Tertiary sediments and weathered Rewan Group) is also unlikely to host significant groundwater. Where saturated, water levels in the regolith are several meters below the base of creek beds.

In the southern part of the site there is potential for intermittent hydraulic connectivity between the regolith and surface drainages during wet periods. However, the ephemeral nature of the creeks indicates a general lack of continual baseflow from groundwater into the creeks. Groundwater modelling with particle tracking (SLR, 2026) shows a hydrogeological connection between the Permian groundwater aquifer and shallow alluvium in the vicinity of Sirius Creek.

There is also the potential for interaction between mine surface water storages such as dams and pits (residual voids), and the hydrogeological units hydraulically connected to them.

Groundwater quality

The physico-chemical results from groundwater sampling at BWM indicate the water chemistry is typically pH-neutral for all geological formations where groundwater is encountered. Very limited data from the alluvial zone indicates a pH of approximately 5 to 6 – consistent with recent rainwater recharge.

Groundwater associated with most geological (and hydrogeological) units have salinity levels (measured as electrical conductivity (EC)), ranging from brackish to saline – median EC approximately 13,000 μS/cm in the non-coal zones of the Rangal Coal Measures; approximately 18,000 μS/cm in the coal seams of the Rangal Coal Measures; to nearly 34,000 μS/cm in the Rewan Group. The Tertiary sediments have the lowest salinity (median of approximately 7300 μS/cm). Major ions in groundwater at BWM are generally dominated by sodium and chloride. Very limited data from the alluvial zone indicates a sodium-calcium-chloride-bicarbonate water type – consistent with recent rainwater recharge.

The existing concentrations of some dissolved metals in the groundwater are above the water quality guidelines (95% protection) for freshwater ecosystems (ANZG, 2018; QWQG 2006). Slightly elevated

concentrations of some elements in groundwater in Permian coal measures in the Bowen Basin are not uncommon and are considered to be naturally occurring.

The water quality from the monitoring wells located at and close to BWM indicates that, generally, the water is unsuitable for human consumption as assessed against the Australian Drinking Water Guidelines (HMRC-NRMMC 2011). Local groundwater use is primarily for livestock purposes owing to the variable salinity levels and generally low yields.

2.3.6 Potential environmental and human health receptors

A conceptual environmental geochemical model (source-pathway-receptor (SPR) model) for BWM identified the potential environmental and human health receptors and are discussed within this report. Of relevance to this assessment (i.e. hazards and risks posed by AMD), the following potential receptors are noted.

Potential surface water receptors

The primary surface water features in the district are the Comet River, located approximately 30 km west of BWM; and the McKenzie River, located approximately 20 km northwest of the northern tip of BWM. Comet River flows north into McKenzie River. As explained in Section 2.3.4., the northern half of the site drains primarily east via Deep Creek and Taurus Creek (and lesser so northwest via Burngrove Creek), all of which eventually drain north into the McKenzie River. The southern half of the site drains west and southwest via Sirius Creek and Rockland Creek, which eventually drain into the Comet River, which flows north into the McKenzie River. Therefore, all of BWM eventually drains into the McKenzie River. BWM shares the McKenzie/Comet River Catchment with several other coal mines upstream of the Comet/McKenzie confluence (e.g. Ensham Mine) and downstream (e.g. Currah North, Jellinbah East and Yarrabee mines). The Comet and McKenzie rivers are implausible receptors for AMD due to their distance from BWM, however their tributaries proximal to the mine are potential receptors.

Potential groundwater receptors

Aquatic and terrestrial groundwater dependent ecosystems (from national assessment) are shown in Figures 1 and 2.

Potential domestic (human) receptors

There are a number of homesteads in the general vicinity of BWM, however none are close to any pits (residual voids), TSFs or spoil dumps and, as such, are considered to be implausible receptors of AMD. The nearest homestead to the current mining area is '*Ausbute*' located about 1.3 km west of Burngrove pit.

There are homesteads that are owned by Whitehaven that are located nearby or within current or future mining areas, or areas that may be impacted by mining. These include '*Memooloo*' homestead, located approximately one km southwest of Comet Downs East residual void (noting that Comet Downs East is a future mining area that has not commenced), '*Mountainview*' located inside the ML over 5 km east of Burngrove residual void and '*Taurus*' homestead, located inside the ML approximately 1.6 km east of Deep Creek residual void. These homesteads are all a significant distance from the residual voids as described are considered to be implausible receptors of AMD.

There are homes/homesteads at Blackwater township – the main township northeast of Bonnie Doon pit and a small group of properties on the northern side of Capricorn Highway northwest of Bonnie Doon pit. The closest homes in this far northern BWM area are located approximately 290 m northwest and

380 m northeast of the ML boundary and approximately 2.2 km northwest and 4.8 km northeast of Bonnie Doon pit. Bonnie Doon pit is the active TSF and will not be expanded (i.e. the 2.2 km / 4.8 km distance from Bonnie Boon pit to the nearest residences will remain the same post closure as it currently is). Blackwater township and properties north of Bonnie Doon pit are considered to be unlikely receptors for AMD from Bonnie Doon TSF (pit).

2.3.7 Acid and Metalliferous Drainage

Environmental geochemical information with regard to AMD from mineral waste materials at BWM has been sourced from the Coal Geochemical Database (hereafter called 'the geochemical database') and is presented and discussed within this report.

2.3.8 Salinity, Sodicity and Dispersion

Environmental geochemical information with regard to salinity, sodicity and dispersion of mineral waste materials at BWM has been sourced from the geochemical database and is presented and discussed within this report. Refer to the main volume of the PRCP for detailed information about soils and rehabilitation of spoil dumps at BWM.

3 Potential Environmental Geochemical Hazards

3.1 Acid and Metalliferous Drainage

The term 'AMD' is used to describe low-quality seepage or drainage (from soil and rock) that has been affected by the oxidation of sulfide minerals (e.g. pyrite) and/or by the dissolution of acid generating sulfate minerals (primarily alunite and jarosite) and associated neutralisation reactions, if any. The term AMD is used to describe any drainage type affected by this process.

AMD may be produced when sulfide minerals (such as pyrite) are exposed to oxygen and water. Oxidation of sulfide minerals may result in the production of acid(ity), sulfate (SO_4) and, depending on mineralogy, the release of metals and salinity. AMD comprises three key components, which are defined below as per recognised Australian and international guidelines (INAP, 2009; DIIS, 2016). This assessment has adopted these definitions:

- Acid drainage (AD): where contact water is acidic and, in most cases, also contains 'elevated' concentrations of metals and metalloids. This drainage type is generated when the acid generating capacity exceeds the acid neutralisation capacity of a sample.
- Neutral and metalliferous drainage (NMD): where contact water is pH-neutral/alkaline and contains 'elevated' concentrations of metals and metalloids. This drainage type is generated when the acid neutralising capacity exceeds the acid generating capacity of a sample.
- Saline drainage (SD): where contact water contains elevated sulfate concentration due to oxidation of sulfide minerals, and very low metal/metalloid concentration. This drainage type is generated when the acid neutralising capacity vastly exceeds the acid generating capacity of a sample with high sulfide concentration.

Whether contact water is impacted by AD, NMD and/or SD largely depends on the relative proportion of acid generating minerals (sulfide / sulfate) and acid neutralising minerals (carbonate) in the source materials.

3.2 Salinity, Sodicity and Dispersion

An assessment of salinity characteristics of mineral waste materials has been undertaken on materials using available EC data from the geochemical database. An assessment of sodicity and dispersion characteristics of spoil materials has also been undertaken using exchangeable cation and Emerson Class data from overburden/interburden samples (data obtained from the geochemical database). Salinity released from the dissolution of geogenic salts (non-oxidative) is a separate and distinct process from SD associated with sulfide oxidation.

4 Assessment Methodology

This section provides the methodology used for the geochemical characterisation and assessment of mineral wastes and coal at BWM.

4.1 Information Review

Sampling and laboratory test-work has been undertaken by throughout the development and operation of BWM. The geochemical database contains all available geochemical data for mineral waste samples. All data has been compiled and reviewed specifically to support the PRCP, to provide a unified and consistent interpretation of all available data. Past characterisation reports are superseded by this review and assessment undertaken to support the PRCP.

4.2 Sample Collection

Drill-hole Samples – representing spoil, ROM coal, pit walls and pit floor

All data used to assess spoil and ROM coal (and pit walls and floor) has been derived from drill-hole sampling. Drill-hole samples have been collected from 47 drill-holes located throughout BWM (shown in Figures 1 and 2) drilled and sampled between 2020-2025.

The drillholes are distributed along strike (approximately north-south) and, as such, intersect all mined geological units along the entire site, with sampling undertaken from surface to full drill-hole depth (approximately to below the lowest mined seam). As such, the drill-hole samples that have undergone test-work are representative of the geology/stratigraphy at BWM from existing mining (disturbance) areas.

The BWM coal resource model provides an estimate of coal resources from current pit highwall through to the eastern extent of the mine (as currently approved). The resource model indicates that – at closure – the proportion of coal versus non-coal in the highwall / end-walls of the residual voids is broadly consistent with the current proportions on the pit highwalls / end-walls. The model also shows that the proportion of each seam group is expected to be broadly similar to current seam group proportions on the highwall and end-walls of the current pits. As such, it is reasonable to assume that the mineral waste types assessed, and their relative proportions, are representative of the mineral waste types and proportions likely to be present at closure.

Geochemical data is available for 4845 drill-hole samples collected from 44 drill-holes. Geochemical samples collected and tested were sourced from the following key mineral waste domains:

- Weathered, non-carbonaceous spoil. 657 samples.
- Weathered, carbonaceous spoil, including weathered coal. 9 samples.
- Fresh, non-carbonaceous spoil. 3515 samples.
- Fresh, carbonaceous spoil. 283 samples. These samples typically include carbonaceous siltstone, carbonaceous sandstone, carbonaceous mudstone and coaly shale, but also includes similar coaly and carbonaceous materials other than coal.
- Fresh, coal. 381 samples.

All samples collected for geochemical analysis were collected from core-drilling. Most samples were collected as discrete samples – typically a 15-25 cm interval of core within targeted sampling zones. Most drill-core samples were collected semi-continuously across the entire stratigraphic sequence from

surface to full depth, with greater emphasis placed on those stratigraphy's posing a greater AMD hazard, such as carbonaceous spoil, plus material located within and very close to coal seams, which includes roof/parting/floor (carbonaceous and non-carbonaceous), and coal. Therefore, in most of the drill-holes, carbonaceous waste type is oversampled relative to its proportion in the stratigraphic sequence. For six (out of 47) drill-holes the entire drill-string was sampled (from surface to full depth), with sampled intervals ranging from approximately 0.1 m to 3.2 m based on lithological and seam boundaries.

It is understood that most fresh coal will report to ROM coal and be processed. A small fraction of coal will be mined as spoil (waste) due to coal quality and mining considerations, and a small proportion of coal will remain exposed in seams on pit walls and floor at closure. The coal samples discussed herein represent 'pure' coal and do not include associated roof, parting and floor samples that would ordinarily be mined with the seam as ROM coal. Carbonaceous roof, parting or floor samples are included in the 'fresh, carbonaceous' sample group.

The geochemical sampling locations are shown on **Figures 1 and 2** and the number of drill-hole samples from each stratigraphic zone is shown on **Figure 3** (indicative stratigraphic column).

Tailings Samples – representing very fine to fine-grained coal process waste

Geochemical data is available (within the geochemical database) for 704 tailings samples, comprising 312 'fresh' tailings samples collected from the NCPP and 392 'aged' tailings samples collected from geochemical and geotechnical investigation drillholes within several TSFs. Tailings data are presented and discussed as two groups being representative of:

- Fresh (NCPP) tailings samples; and
- Aged (TSF) tailings samples.

Tailings samples collected from the NCPP are deemed to be representative of 'fresh' tailings currently and recently produced at BWM. Tailings samples collected from TSFs are deemed to be representative of 'aged' tailings within the TSFs at BWM.

Most of the 'aged' tailings samples collected from TSFs were logged as 'dry to moist' or 'moist' at the time of sample collection.

Rejects Samples – representing mid- to very coarse coal process waste

Geochemical data is available (within the geochemical database) for 398 rejects samples, comprising 48 'fresh' rejects samples collected from the NCPP and 350 'aged' rejects samples collected from geochemical and geotechnical investigation drill-holes and test pits within the TSFs and rejects dumps at BWM. Rejects data are presented and discussed as two groups being representative of:

- Fresh rejects samples (from NCPP); and
- Aged rejects samples (from TSFs and rejects dumps). These samples were predominantly logged as 'dry' to 'moist' or 'moist' at the time of collection.

Rejects samples collected from the NCPP are deemed to be representative of 'fresh' rejects currently and recently produced at BWM. Rejects samples collected from TSFs and rejects dumps are deemed to be representative of 'aged' rejects that may be found in TSFs or at rejects disposal areas awaiting burial/rehabilitation.

Fill and Natural Ground Samples Associated with TSFs

Limited geochemical data is available for 64 'fill' (assumed spoil) samples collected from within TSFs; primarily from the spoil cap currently on Laleham TSF and 'fill' material (assumed spoil) within one of the NCPP TSF embankments. Limited geochemical data is also available for 33 'natural ground' samples collected from below (i.e. the base of) Laleham TSF, Ramp 36 rejects dump and NCPP TSF embankments. The geochemical characteristics of these samples are not presented and discussed in this assessment in detail, however are referred to where relevant.

4.3 Sample Characterisation

The aim of the environmental geochemical test-work is to understand the geochemical characteristics of the mineral waste materials with respect to AMD, geogenic salinity, erosion and dispersion potential; and to inform management and closure options for these materials.

A phased approach was implemented to define the geochemical behaviour of the key material types generated at BWM, as discussed below.

Solid Samples – Static Tests

Tailings, rejects and overburden (spoil) samples have generally undergone similar test-work methods. Test-work was generally undertaken in stages, with most samples being subjected to 'screening' tests followed by more detailed test-work undertaken on selected samples.

The vast majority of the samples have undergone 'screening' tests (stage 1 tests) for:

- pH and electrical conductivity (EC) on 1:5 w:v water extracts (on pulps [100% passing 212 microns]);
- Net acid producing potential (NAPP) test, which comprises total sulfur (total S) and acid neutralising capacity (ANC) determination. The NAPP test provides the fundamental information about the theoretical maximum amount of acid-producing and acid-neutralising material that a sample could produce.

Based on the results of the screening tests, selected samples were subjected to some or all of the following tests:

- Total carbon (total C), and organic carbon (C-org);
- Total sulfate (SO_4);
- Sulfide (chromium reducible sulfur – Scr) – a test to determine the proportion of total S present as sulfide;
- Acid buffering characterisation curve (ABCC) - a test to determine the proportion of ANC that's in a readily-available form and to provide an indication of the carbonate mineralogy of the neutralising material;
- Net Acid Generation (NAG) [single addition] - a test that encourages the oxidation of a sample to determine if acid can be produced, and how much acid could be produced;
- Sequential net acid generation test (S-NAG) – a refinement of the single addition NAG test to resolve potential issues associated with incomplete oxidation of samples with high sulfide concentrations;
- Extended boil net acid generation test (NAG Extended) – a refinement of the NAG test to resolve uncertainty due to potential organic acid interference (where non-acid generating organic acids can provide false positive results in the NAG test);

- Total metals and metalloids by 4-acid (mixed) or 2-acid (aqua regia) digest with analysis by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and/or Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) and Flow Injection Mercury System (FIMS);
- Quantitative x-ray diffraction (QXRD) – to determine the mineralogical composition;
- Short-term leaching tests, including:
  - Deionised water extract leach procedure – a 1 hour end-over-end bottle leach at 1:5 w:v (solid:water) ratio using de-ionised water, with filtered leachate analysed for:
    - Major and minor ions [calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), SO_4, chloride (Cl) and fluoride (F)];
    - Alkalinity [total alkalinity, bicarbonate (HCO_3) and carbonate (CO_3)] and Acidity (pH dependent);
    - Soluble metals/metalloids [approximately 28 elements by ICP-MS, ICP-AES and FIMS].
  - Saline water extract leach procedure – a 1 hour end-over-end bottle leach at 1:5 w:v (solid:water) ratio using saline water (2 g/L NaCl), with filtered leachate analysed for the soluble analytes listed above.
  - Peroxide (NAG) leach – analysis of the solution on completion of the NAG or NAG Extended test, with filtered leachate analysed for the same (or similar) suite of soluble analytes as listed above.
- Exchangeable cations (Calcium [Ca], Magnesium [Mg], Sodium [Na], Potassium [K]) (with pre-treatment for salinity, if required). Results were used to calculate the cation exchange capacity (CEC);
- Emerson Aggregate Class testing.

Geochemical test work was undertaken by ALS Environmental (ALS) Brisbane, using National Association of Testing Authorities (NATA) accredited methods (where such accreditation exists). Mineralogical analysis (QXRD) was undertaken by a university (research) mineralogical laboratory in Melbourne (via Earth Systems Consulting).

Solid Samples – Kinetic OxCon Tests

Oxygen consumption and carbon dioxide (CO_2) generation (OxCon) test-work was undertaken by Earth Systems (Melbourne) on five 'fresh' tailings samples from NCPP, one 'aged' tailings sample collected from NCPP TSF, and three composite carbonaceous spoil samples from drill-cores. The samples were selected on the basis of earlier static test results.

OxCon is a laboratory-scale kinetic geochemical test for the estimation of sulfide oxidation rates, acidity generation rates and carbonate neutralisation rates for sulfidic geological materials.

Prior to the OxCon test the sample is 'washed' to remove any pre-existing salts and oxidation products (e.g. sulfate). Test-work then involves isolating a known mass of sulfide-bearing material in a known volume of oxygen inside a sealed vessel and allowing sulfide oxidation to proceed. Once the test is initiated, oxygen in the vessel is consumed via sulfide oxidation. Oxygen consumption is measured directly and logged over the test-work period (1-8 weeks, depending upon the sample). Carbon dioxide generation is measured directly and logged for estimation of the extent of acid neutralisation by carbonate minerals or the rate of biological organic carbon oxidation, if any, during testing. The test is run under low moisture conditions (8 wt.% gravimetric moisture content) and assumes full oxygen availability to support oxidation reactions (i.e. sample at surface).

At the conclusion of the OxCon test, the solid undergoes a bottle leaching procedure at a 1:2 solid:water ratio and the leachate was analysed to determine the pH, acidity/alkalinity and concentration of soluble metals/metalloids and salts.

Solid Samples – Kinetic Leaching Tests

Free-draining kinetic column leaching data is available for five fresh (NCPP) tailings samples and one 'aged' tailings sample collected from NCPP TSF. The samples were selected for column leaching test-work on the basis of earlier static test results. These are the same tailings samples that also underwent OxCon test-work.

Column leaching is a laboratory-scale kinetic geochemical test for the estimation of sulfide oxidation rates, acidity generation rates and element leaching – over time – for geological materials. The intent of the column leaching program was to characterise leachate from samples subjected to routine wetting and drying cycles, which simulates exposure to 'atmospheric conditions'. Crushed samples are loosely packed into a two litre funnel and a known quantity/mass of deionised water is slowly added to the top of each sample and the water allowed to slowly free-drain through the sample matrix and collected as 'column leachate'. The leachate collected from each column test was analysed to determine the pH, acidity/alkalinity and concentration of soluble metals/metalloids and salts. Between leaching (wetting) events the sample matrix was allowed to dry and oxidise using heat lamps. The column leaching test method was based upon a modified AMIRA (2002) method.

Tailings Liquor Samples

Tailings samples collected from the NCPP are collected as a slurry – representative of the tailings slurry that reports to TSFs for disposal. At the TSF the water drains to one end of the TSF – called a decant pond/area – and is collected for re-use in the NCPP. Geochemical data is available (in the geochemical database) for tailings liquor from 51 sampling events undertaken at the NCPP between August 2020 and August 2023. The liquor samples were analysed for a typical suite of water quality parameters, such as pH and EC, major cations and anions and soluble metals and metalloids.

4.4 Geochemical Source Hazard Assessment

Geochemical data was assessed with regard to the samples potential to generate AMD. Only after making such an assessment to understand the potential AMD hazard can appropriate AMD-specific management measures be formulated to adequately mitigate the risks, as required.

AMD classification

The Acid-Base Account (ABA) method was used to assess the acid-neutralising and acid-generating characteristics of the samples in order to determine an acid (AD) classification for the rejects.

The maximum potential acidity (MPA) and acid neutralising capacity (ANC) represent each side of the acid-base account. MPA is calculated from total S and is the theoretical maximum potential acidity that can be generated if all of the S, assumed to be associated entirely with pyritic sulfide, is able to oxidise and generate acid (H_2SO_4). ANC represents the theoretical maximum amount of acid-neutralising capacity of a sample assuming all neutralising material is in a readily available form. The net acid producing potential (NAPP) is the difference between the MPA and the ANC. In simple terms, a negative NAPP indicates an excess of ANC and the sample is likely to be non-acid forming (NAF) and a positive NAPP indicates an excess of MPA and the sample is likely to be potentially acid forming (PAF) – though there can be exceptions to this simplified interpretation. Note that NAF samples have the potential to generate NMD and SD, depending on the sulfur concentration.

Sample classification of mineral wastes follows some general rules. Samples were initially classified using Total S, NAPP and ANC/MPA ratio (and NAG data, where available), into three broad categories:

NAF Non-acid Forming;

PAF Potentially Acid Forming;

Uncertain Those samples with inconclusive results, leading to a degree of uncertainty about their ability to generate acid.

Where available, additional geochemical information such as pH, Scr, ABCC, NAG extended and NAG sequential results were used to resolve acid classification uncertainties. The general approach was to build in a level of conservatism in the preliminary classification, as shown in **Table 2**.

Table 2. Preliminary AMD classification criteria

Preliminary classification	Sulfur %	NAPP kg H2SO4/t	ANC/MPA ratio	NAGpH (if data available)
NAF	≤ 0.01	-	-	-
	≤ 1	< 0	≥ 2	-
	≤ 1	< 0	-	≥ 4.5
NAF-Sulfur (NAF-S)	> 1	< 0	≥ 2	-
	> 1	< 0	-	≥ 4.5
PAF – Low Capacity (PAF-LC)	≤ 1	≥ 0 and < 10	< 2	-
	-	≥ 0 and < 10	-	< 4.5
PAF	-	≥ 10	< 2	-
	-	≥ 10	-	< 4.5
Uncertain	Any result outside of the above criteria, or results that appear to significantly conflict with the expected result based on lithology or mineralogy			

Samples with an uncertain NAF or PAF classification are given a tentative sub-classification of UC(NAF) or UC(PAF), where preliminary data suggests the sample is expected to be NAF or PAF, respectively.

Sulfur category

To ensure a consistent approach to describe the geochemical characteristics of the sample, specific total S cut-off values were used to discuss sulfur data, as shown in **Table 3**.

Table 3. Sulfur category

Sulfur category	Total S (wt. %)	Sulfur category	Total S (wt. %)
Very low	< 0.1	Moderate	1.0 – 1.5
Low	0.1 – 0.5	High	> 1.5
Low-moderate	0.5 – 1.0		

ANC category

To ensure a consistent approach to describe the geochemical characteristics of the sample, specific ANC cut-off values were used to discuss ANC data, as shown in **Table 4**.

Table 4. ANC category

ANC category	ANC (kg H_2SO_4/t)	ANC category	ANC (kg H_2SO_4/t)
Very low	< 5	High	30 - 50
Low	5 - 15	Very high	> 50
Moderate	15 - 30		

Soil salinity

The term 'soil' salinity (and 'soil' pH – refer below) is an industry-adopted term to refer to the salinity and pH measured on any solid geologic matrix, such as soil, spoil, rock, sediment, tailings, reject, etc. That is, in this context, the term 'soil' applies to all solid samples, not just shallow surface (root zone) material.

Classifying whether a sample is non-saline, highly saline, or somewhere in between will depend upon the methods used to measure soil salinity. Soil salinity data is obtained from a 1:5 (w:v) water extract procedure typically on pulp samples. The soil salinity classes shown in **Table 5** are expressed in units of microSiemens per centimetre (μS/cm) and are used as an indicative guide. The classes are broadly based on soil salinity classes reported by DME (1995).

Table 5. Soil salinity classification

Soil salinity classification	EC1:5 (µS/cm)	Soil salinity classification	EC1:5 (µS/cm)
Non-saline	< 450	Saline	2000 - 4000
Slightly saline	450 - 900	Strongly saline	> 4000
Moderately saline	900 - 2000		

Soil pH type

Classifying whether a sample is acid, pH-neutral or alkaline or somewhere in between will depend upon the methods used to measure soil pH. Soil pH data is obtained from a 1:5 (w:v) water extract procedure on pulp samples. These soil pH types shown in **Table 6** are used as an indicative guide.

Table 6. Soil pH type

Soil pH type	pH1:5	Soil pH type	pH1:5
Highly acid	< 3.0	Near neutral	6.0 – 7.5
Moderately acid	3.0 – 4.5	Alkaline	7.5 – 9.0
Weakly acid	4.5 – 6.0	Highly alkaline	> 9.0

Mineralogy

Potential mineralogical data (QXRD) provides supporting information for the geochemical data, particularly with regard to sulfide and carbonate mineralogy of a sample, showing results for mineralogical forms (e.g. what sulfide or carbonate minerals are present) and their concentrations (reported in weight %). These data also assist with interpretation of the ABA data.

Element enrichment

The total concentration for each element were compared to average element abundance in soil in the Earth's crust (AusIMM 2011; Bowen 1979) to measure how the total elemental concentrations in the samples compare against average elemental concentrations in un-mineralised soil (worldwide). Such a comparison is undertaken to identify samples that contain what may be regarded as 'elevated' concentrations of metals and metalloids to identify potential element of concern. However, enrichment in any metals/metalloids in the solids, does not translate to enhanced leachability or mobilisation and/or bioavailability of that specific element.

Elements identified as enriched may not necessarily be a concern for revegetation and rehabilitation, human and animal health or drainage water quality. Similarly, if an element is not enriched it does not mean it would not be mobilised, because under some conditions (e.g. low pH, reducing conditions) the geochemical behaviour of metals/metalloids such as Al, As, Cu, Cd and Zn can change (i.e. become less or more mobile).

From the comparison with average crustal abundance in rocks a geochemical abundance index (GAI) was calculated. The GAI quantifies an assay result for a particular element in terms of the average abundance for that element (in sedimentary rocks). The index, based on a log 2 scale, is expressed in seven integer increments (0 to 6), which correspond to enrichment factors from 0 to over 96 times average crustal abundance, as shown in Table 7.

As a general rule, a GAI greater than or equal to three indicates enrichment compared to un-mineralised shale that may warrant further investigation to assess the mobility of these elements under laboratory conditions.

Table 7. Geochemical Abundance Index (GAI)

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

It is important to note that determining average element abundance with any degree of accuracy on an Earth scale is difficult. As such, for any given element, there is a large range of average concentration values throughout the published literature dating back over 70 years. For many elements the published values differ by orders of magnitude. As such, the use of GAI values is simply an attempt to provide context to the assay data (total metals and metalloid results).

Solubility

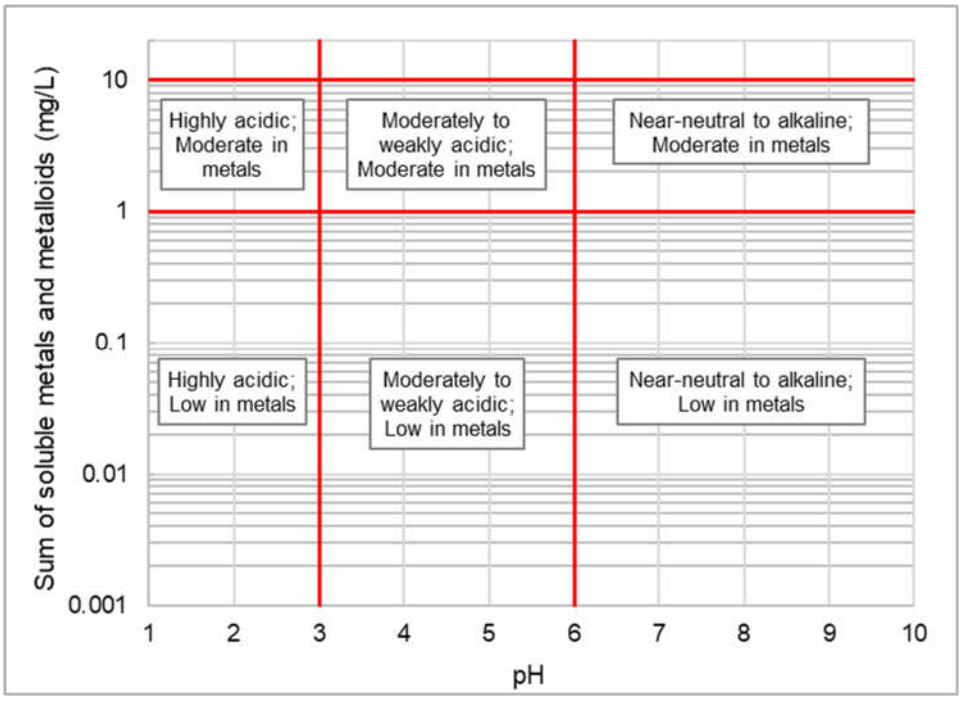
Metal/metalloid mobility from samples has been assessed using deionised water and peroxide (NAG) leaching methods. The deionised water leaches assess the initial solubility under fresh water conditions, whereas the peroxide leach assesses the solubility after the samples have been oxidised.

The solubility data from bottle leaching provides an indication of likely solubility/release of salt and metals/metalloids under field pH and redox (oxidation) conditions (and/or low-pH conditions, where applicable). Peroxide (NAG) leachate data provides an indication of potential acidity and concentrations

of metals and metalloids that could be released from samples that are fully and rapidly oxidised. This test provides an assumed 'worst case' scenario in term of metal/metalloid mobility.

A classification scheme initially developed by Ficklin *et al*. (1992) has been adapted to summarise major attributes of the solubility data by plotting pH against the summed soluble metal and metalloid concentrations for groups of elements, with the classification scheme shown in **Figure 4**. The soluble metal and metalloid concentrations are shown as the sum of soluble (dissolved) metal and metalloid concentrations for aluminium (Al), antimony (Sb), arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se), uranium (U) vanadium (V) and zinc (Zn). These elements are chosen because they're potentially environmentally important elements (as relevant to Permian coal deposits) and/or many of the elements remain in solution across a wide range of pH and are not only potentially associated with AD conditions, but also with NMD/SD conditions.

Figure 4. Classification of soluble metals and metalloids as a function of pH



No comparison is made between leachate results and water quality guideline values, such as ANZG (2018) (or the draft ANZG 2023 guidelines), as such a comparison is inappropriate. The guideline values provided in ANZG (2018/2023) are for receiving water environments (e.g. creeks), whereas the soluble element data in this assessment is 'point source' obtained from a finely pulped sample subjected to rigorous and artificial extraction to obtain a concentration approaching 'near maximum'. Furthermore, contact water will undergo a number of geochemical reactions along a pathway from source to receptor, including retardation, adsorption and precipitation – and also likely dilution, which will attenuate the concentration as seepage/contact water migrates from the source. These processes are not accounted for in a laboratory setting.

Sodicity and dispersion

Potential spoil samples (representing material that is likely to report to final landform surfaces) are broadly classified with respect to sodicity on the basis of the exchangeable sodium percentage (ESP) value, as shown in **Table 8** (after Northcote and Skene, 1972; Isbell, 2002).

Table 8. Sodicity classification

Sodicity classification	ESP (%)
Non-sodic	≤ 6
Sodic	6 - 14
Strongly sodic	> 14

The sodicity will depend upon a range of factors, such as clay mineralogy, soil sodium concentration, soil salinity and irrigation water (rainwater) chemistry, which may enhance or limit that potential for soil to be sodic or become sodic over time. Therefore, values of 6% ESP and 14% ESP to represent soils as being sodic or strongly sodic are used as a general guide only and should not be taken as definitive. Sodicity assessments only apply to materials likely to report to final landform surfaces, such as overburden/interburden (i.e. not tailings, rejects or waste coal).

Sodicity information is broadly used to understand potential revegetation and dispersion aspects, and is supported by Emerson Aggregate Class test information, which provides a direct measure of soil slaking and dispersion based on the Standards Australia (2017) classification. Soils are divided into classes on the basis of their coherence in water and presence (or absence) of calcium-rich minerals (Table 9). Slaking occurs when dry soil crumbs, after being immersed in deionised water, break up and run along the bottom of the beaker into a flat pile. Most dry soil crumbs slake when immersed in deionised water. Dispersion describes the tendency for the clay fraction of a soil to go into colloidal suspension in deionised water. Materials are generally regarded as being dispersive (or prone to dispersion) if they have an Emerson Class number of three or less.

Table 9. Emerson classifications

Class	Description	Class	Description
1	Slaking and complete dispersion	5	No calcite or gypsum present; dispersion
2	Slaking and some dispersion	6	No calcite or gypsum present; flocculation
3	Dispersion [remoulded]	7	Non-slaking and swelling
4	Calcite or gypsum present; no dispersion	8	Non-slaking and non-swelling

4.4.1 Using coal quality data for AMD classification

Coal quality data has been used to aid with the assessment of AMD hazard associated with coal seams. In particular, the BWM coal quality database was used to supplement the geochemical database and provide additional understanding of the AMD potential of likely ROM coal, remnant coal, waste coal and rejects. Coal plys were grouped into their respective seam groups on a per-pit basis, such as T, MR, P & L Upper, P & L Lower, etc. for each pit group.

Total S concentrations can be used conservatively to assess the AMD hazard for any given sample; thus, statistical analyses were conducted on total S as a function of seam group and for all seams combined to define the AMD hazard of coal. The data were used to understand the sulfur grade range for each seam group to gain an understanding of the potential AMD hazard posed by each coal seam group (and by inference, potential tailing and reject materials). The results were then compared with detailed geochemical data available for coal, rejects and tailings to 'calibrate' the coal quality total sulfur data.

Coal samples from less than 20m depth were assumed to be completely or predominantly oxidised and were interpreted as 'weathered carbonaceous spoil' and, therefore, excluded from the assessment of potential ROM coal. Acid producing sulfate minerals, such as jarosite, may be present within weathered coal and carbonaceous material, however, mineralogical data available from BWM shows that jarosite is an insignificant mineral at BWM.

4.4.2 Residual void highwall and end-walls assessment

An assessment of the AMD hazard associated with exposures of all lithological materials, such as remnant coal, weathered materials, fresh non-carbonaceous and carbonaceous overburden was undertaken – being representative of the highwall and end-walls of the residual void associated with a given pit group.

The frequency of occurrence of relevant material types within each pit was determined from the stratigraphic distribution within selected drill holes under the assumption that the frequency of distribution of each material type is broadly indicative of their respective surface exposures on current highwalls and end-walls. For example, if P & L Upper seam group had a frequency of occurrence (by meters) of 5% in the drill-hole data set, then the assumption is that the same coal seam group would represent approximately 5% of the surface exposure on the highwall and end-walls. This method - whilst being relatively simple - provides an acceptable approximation with regard to which seam groups or mineral waste types are most likely to be significantly present in pit walls versus those material types most likely present in relatively minor proportions.

To estimate the proportion of key material domains on the walls in each void, exploration drill-holes in proximity to the current/recent highwall/s (and future void highwalls for undeveloped pits) were selected by BWM Coal Geology Planners for each pit. Most holes extended to depths approximating future pit floor depths. For existing pit areas, many drillholes were used for the assessment of each pit/void area. For the proposed future pit areas where limited drillhole data is currently available (i.e. South Marshmead, Kennedy and Comet Downs East proposed pit areas) the assessment was supplemented by estimating depths (thicknesses) of each stratigraphic zone based on the geological model for the southern BWM area.

Stratigraphy, age, weathering, location with respect to the water table, and major stratigraphic horizons (as recorded in the BWM coal geology database) were used to assign individual (discrete) lithological units to a material domain as follows:

- Weathered non-carbonaceous;
- Weathered, carbonaceous [includes weathered coal];
- Fresh, non-carbonaceous;
- Fresh, carbonaceous;
- Fresh, coal.

Coal plys were grouped into their respective seam groups, such as T, MR, P & L Upper/ Lower, etc.

For each void highwall, a statistical assessment was conducted on each drill-hole sub-set (as applicable to each pit group) to summarise the frequency of occurrence of drill core intervals as a function of each of the material groups listed above.

The inherent AMD hazard of each material group listed above was inferred from the geochemical database and coal quality database for similar material types. The combined AMD hazard for the material groups likely to be exposed on the highwall was then used to estimate the AMD hazard of the highwall and end-walls at each pit.

4.4.3 Residual void floor assessment

An assessment of the AMD hazard associated with remnant coal exposed on the floor of each void was undertaken – being representative of the floor of the residual void associated with a given pit group.

As explained in Section 4.4.1 coal quality data was assessed to understand the potential AMD hazard associated with coal. For the task of assessing the AMD hazard specific to pit floors (on a pit-group basis), only the coal quality data from the seam group likely to form the pit floors at a given pit group was assessed. At BWM the P & L Lower seam group forms the floor of all pits except Ramp 74 pit.

At Ramp 74 pit the TR seam (T seam group) forms the floor of the pit, however Ramp 74 pit contains tailings from NCPP – therefore the floor of this pit is now tailings (Ramp 74 TSF). Bonnie Doon pit is currently the active TSF – therefore the floor of this pit is now tailings.

It is acknowledged that there are generally minor geochemical differences between the various plys of any given seam group. Also, the AMD hazard of the floor of a pit may change depending on whether a significant proportion of the pit floor resides on coal(ly) or non-carbonaceous material. Furthermore, the AMD hazard of any pit floor is not just associated with its surface exposure, but more so with the composition of the sub-drill zone, which represents an extensively fractured coal / interburden comprising the upper sections of a pit floor. For this assessment, the AMD hazard was estimated only for assumed surface exposures of coal / plys.

In practice, mining takes all coal to the bottom of the seam at the base of a pit, therefore very little coal would be expected to remain on the floor of the voids. As such, the assessment has adopted a highly conservative position assuming the floor of each void is all coal, and the coal is completely exposed.

4.4.4 TSF assessment

At closure, NCPP TSF will remain as a discrete facility (TSF landform). This TSF is non-operational (currently authorised for emergency tailings disposal) and will undergo rehabilitation prior to or during mine closure. Geochemical data from samples collected from within NCPP TSF were used to assess the geochemical AMD source hazard of this facility. The AMD source hazard was also assessed using tailings and rejects geochemical data from the NCPP representing 'fresh' tailings and 'fresh' rejects samples.

At closure, Laleham TSF will also remain as a TSF landform. This TSF has undergone preliminary rehabilitation and will undergo additional rehabilitation prior to or during mine closure. Geochemical data from samples collected from within Laleham TSF were used to assess the geochemical AMD source hazard of this facility. Very limited rejects data was available specifically from Laleham TSF. As such, the AMD source hazard was also assessed using rejects geochemical data from all of site.

Ramp 72 TSF will be buried by bulk spoil during mining operations and therefore, at closure, will not require specific remediation or rehabilitation as it will lie beneath the Kenmare spoil landform. Bonnie Doon pit and Ramp 74 pit (both containing tailings) are assessed as voids with tailings floor.

Bottom Dam TSF/rejects facility is located in a gully on the southeastern side of SCPP ROM 3 (**Figure 2**) – with the total volume conservatively estimated at approximately 0.2 Mm^3. Bottom Dam area is currently

undergoing an environmental and engineering assessment program and the results of this program will inform rehabilitation and closure planning.

4.4.5 Rejects dump assessment

At closure, Ramp 36 rejects dump will remain as a discrete facility (rejects landform). This facility is non-operational. Ramp 36 rejects dump will undergo rehabilitation prior to or during mine closure. The AMD source hazard assessment of this facility has utilised geochemical data from reject samples collected the Ramp 36 rejects dump.

TCP rejects (up to 0.1 Mm^3) will be relocated from the TCP into the Mimosa-Besgrove spoil landform during rehabilitation of the TCP area and, as such, will not remain as a rejects landform post-closure.

The southern end of Kenmare pit contains a mix of tailings and rejects that were excavated from the old TSF at Red Dam and Upper Red Dam (and disposed into Kenmare pit). These tailings/rejects are within the Kenmare spoil landform.

Rejects are disposed adjacent to, and in the general vicinity of, Bottom Dam TSF. These rejects will be incorporated into the rehabilitation of Bottom Dam TSF, before covering with spoil.

Other rejects disposal areas (e.g. Deep Creek rejects disposal area) are located within a spoil landform area and will be buried by spoil during mining operations.

4.4.6 AMD hazard scoring

Estimating the AMD hazard is the first step in estimating the geochemical risk associated with potential sulfide oxidation of mineral wastes. A procedure has been developed[2] to standardise the AMD hazard assessment across material domains, with the process described below.

AMD hazard scoring and the AMD geochemical likelihood describe the Geochemical Hazard. The former describes the hazard for AMD generation and the latter describes the likelihood of an AMD event to occur.

A source material is a distinct material type (e.g. non-carbonaceous spoil or rejects or tailings), whereas a landform is a domain comprising one or more source material types (e.g. rejects disposed within non-carbonaceous spoil). AMD hazard scorings are assigned for individual source materials reporting to a landform as well as to landforms as a whole (i.e. landform AMD hazard score).

The likelihood of a landform developing AMD was determined based on the landform AMD hazard score. AMD hazard scores (**Table 10**) are estimated by analysing three key components, which are used to describe the geochemical hazard of a source material/landform:

- Propensity to generate AMD;
- AMD capacity (i.e. the severity of the AMD, if generated); and
- AMD quantity (i.e. the amount of material that could generate AMD).

These three component terms are explained following **Table 10**.

2 The AMD hazard scoring matrix was developed by the author in conjunction with Dr. Marilena Stimpfl (BHP Closure Planning) for use in coal mining assessments.

Table 10. AMD hazard scoring matrix for landforms

Component	Rating		Definition
Propensity for AMD generation Per material type: - non-carb. - carb & coaly - rejects - tailings	1	Implausible	Geochemical properties suggest that the vast majority of the source material has a negligible potential for AMD generation (less than 5% of the samples classified as 'PAF' or NAF-S).
	5	Plausible	Geochemical properties suggest that a significant proportion of the source material may have potential for AMD generation (5-40% of the samples classified as 'PAF' or NAF-S).
	7	Expected	Geochemical properties suggest that the source material has a high potential for AMD generation, but AMD has not yet been observed in the field (due to lag time) - (>40% of the samples classified as 'PAF' or NAF-S).
	15	Certain	Evidence of AMD processes have been observed in the field from the source material.
AMD **Capacity** Per material type: - non-carb. - carb & coaly - rejects - tailings	1	Low	Source material has a negligible potential for AMD generation. 'PAF' and NAF-S samples have 75th percentile total S less than 0.1%.
	3	Low-Moderate	Assumed to be bulk NAF but sulfide bearing, with NAF samples having 75th percentile total S greater than 1% (i.e. the material is predominantly NAF-S). AMD generated will be NMD and/or SD (related to sulfide oxidation), not AD.
	5	Moderate	'PAF' and NAF-S samples have 75th percentile total S ranging from 0.1% to 1.0% and with potential to generate AD.
	7	Moderate-High	'PAF' and NAF-S samples have 75th percentile total S ranging from 1.0% to 1.5% and with potential to generate AD.
	10	High	'PAF' and NAF-S samples have 75th percentile total S greater than 1.5% and with potential to generate AD.
AMD **Quantity** Per material type: - non-carb. - carb & coaly - rejects - tailings	1	Low	Source material rated LOW for AMD capacity; or less than 5% of source material reporting to a landform is rated LOW-MODERATE for AMD Capacity.
	3	Low-Moderate	Less than 5% of source material (in the landform) rated as Moderate for AMD capacity.
	5	Moderate	Greater than 5% of source material (in the landform) rated as Low-Moderate or Moderate for AMD capacity.
	7	Moderate-High	Less than 5% of source material (in the landform) rated as Moderate-High or High for AMD capacity.
	10	High	Greater than 5% of source material (in the landform) rated as Moderate-High or High for AMD capacity.
AMD Quantity Per residual void. Per wall component. Per floor.	1	Low	Less than 10% of drill-hole meters of source material (or less than 10% of pit floor exposure) are classified as 'PAF' or NAF-S.
	5	Low-Moderate	Between 10% and 30% of drill-hole meters of source material (or 10-30% of pit floor exposure) are classified as 'PAF' or NAF-S.
	7	Moderate-High	Greater than 30% of drill-hole meters of source material (or greater than 30% of pit floor exposure) are classified as 'PAF' or NAF-S.
	15	High	Evidence of AMD on walls or floor of pit; or AMD affected water in pit.

In undertaking the AMD hazard assessment, the assumption is that the source materials within the landforms will predominantly be dry or moist, but not wet or saturated. That is, the landforms will be unsaturated. This assumption is realistic, since most spoil landforms, rejects landforms and aged/inactive TSF landforms are generally unsaturated, excluding the deeper zones of in-pit landforms that may interact with a void lake. This assumption is also conservative, since the potential for oxidation (to some degree) is assumed.

AMD Propensity is the tendency of a given material type to generate AMD. The propensity to generate AMD is determined based on the proportion of samples that have potential for AMD as determined from laboratory test-work and the subsequent assessment – the higher the percentage of materials that can generate AMD within a sample set, the greater the AMD propensity. This approach is conservative, since sampling is slightly skewed towards material types considered to pose a potentially higher AMD hazard, such as carbonaceous materials.

AMD Capacity represents the 'severity' of AMD generation, with total S concentrations used as a proxy for scoring this component, which represents a conservative approach as some sulfur is associated with non-acid generating minerals. For example, the higher the total S concentration in materials with potential for AMD, the higher the hazard, the higher the score. Furthermore, the AMD capacity also takes into account the type of drainage a source material can produce, i.e. AD, NMD and/or SD, where discrimination or prediction is possible. The various drainage types should be differentiated (where the data allows) to reflect the difference in impact severity and difficulty to manage or treat. For example, on an equal quantity basis, AD is likely going to cause more severe impacts than NMD or SD and therefore is assigned a higher score.

As a first approximation the AMD Capacity of each material type is estimated based on the 75th percentile value of the total S concentration for the samples classified as PAF and NAF-S. This is a conservative assumption, as not all total S is associated with reactive minerals and choosing the 75th percentile total S value of PAF and NAF-S samples to assess the AMD capacity will attract a higher AMD Capacity scoring. For example, if two material types had the same proportion of samples with the same propensity for AMD, but one has a higher total S concentration associated with PAF and NAF-S materials, then this sample would receive a higher AMD Capacity score.

Generally, amongst Bowen Basin Permian- and Tertiary-age materials, a very small number of samples are classified as NAF-S – almost all samples with high total S (>1%) are typically classified as 'PAF' of some type. Therefore, AMD Capacity does take into consideration potential NMD/SD by including NAF-S samples with PAF samples, however the very few NAF-S samples (compared to PAF samples) means that NAF-S samples typically have a negligent bearing on the AMD Capacity of a material. For example, of the 5949 samples (of all types) at BWM that underwent geochemical characterisation, only 38 samples were classified as NAF-S (approximately 0.6% of all samples) – and 34 of the 38 samples were tailings and rejects.

AMD Quantity is the amount of material (tonnage/volume) that has the potential to generate AMD. The greater the tonnage/volume of AMD generating material the greater the hazard scoring. The AMD Quantity scores are assigned to material types for each landform.

4.4.7 Landform AMD likelihood scoring

The likelihood of a landform generating AMD is estimated by analysing two key components:

- Source material AMD hazard score; and
- Landform AMD hazard score.

Source material AMD hazard score: Describes the potential for AMD generation by the respective material types within each landform. It is estimated from the weighted combined scores of each component used to describe the AMD source hazard:

  - Propensity to generate AMD. Assigned a 50% weighting (weighting = 1);
  - AMD capacity. Assigned a 25% weighting (weighting = 0.5); and
  - AMD quantity. Assigned a 25% weighting (weighting = 0.5).

Landform AMD hazard score: Describes the likelihood for AMD generation by each final landform and each residual void. It is estimated from the source material AMD hazard scores for each material type assumed to be present within that specific landform. At closure, BWM has 14 spoil landforms and 13 residual void domains, three TSF landform domains (NCPP TSF, Laleham TSF and Bottom Dam TSF [Bottom Dam TSF domain includes rejects]; and one rejects landform domain (Ramp 36 Rejects), as listed in Section 2.2.

- Landforms: the landform AMD hazard score is estimated from the weighted average of the source material AMD hazard and the proportion of PAF and NAF-S waste expected to report to the landform from each material type.
- Residual voids: the landform AMD hazard score is estimated from the average of the source material AMD hazard scores for each material type likely to be exposed on the walls or floor of each residual void.

To support the assessment of the AMD closure risks, the landform AMD hazard score is assigned a likelihood score (Table 11) as consistent as possible with Whitehaven Coal's risk management methodology, which is broadly aligned with ISO 31000. ISO 31000 is a family of standards relating to risk management codified by the International Organization for Standardization. For landforms and residual voids with AMD hazard scores between 10 and 20 a preliminary likelihood of 'Probable / Likely' is assigned unless/until kinetic data are available to provide a time frame for AMD generation. This likelihood can be revised as more data, such as kinetic or field data, becomes available.

Table 11. AMD hazard ranking and landform/void AMD likelihood ranking

Landform AMD hazard scores	Landform AMD likelihood
0 - 5	Highly Unlikely: Highly unusual; may occur in extreme circumstances
5 - 10	Unlikely: Known to occur, but only rarely
10 - 15	Probable: May reasonably occur
15 - 20	Likely: Could easily occur
>20	Highly Likely: Expected to occur

5 Results

Environmental geochemical data is available for 5947 samples – all of which have undergone a range of environmental geochemical tests. The samples are representative of the following mineral waste and coal groups:

Spoil

- Weathered Non-carbonaceous: Overburden. 657 drill-hole samples;
- Weathered Carbonaceous: Overburden/interburden [includes weath. coal]. 9 drill-hole samples;
- Fresh, Non-carbonaceous: Overburden/interburden. 3515 drill-hole samples;
- Fresh, Carbonaceous: Overburden/interburden. 283 drill-hole samples.

Coal

- Fresh Coal: Representative of ROM coal. 381 drill-hole samples

Tailings

- Fresh tailings from NCPP. 312 samples
- Aged tailings from the TSFs. 392 drill-hole samples

Rejects

- Fresh rejects from NCPP. 48 samples
- Aged rejects from various locations: 350 samples (in total) from NCPP TSF, Laleham TSF, Ramp 72 TSF, Ramp 36 rejects dump and Red Dam area.

5.1 Mineralogy

Data is available for 74 samples, comprising: 45 spoil samples, 22 tailings samples (9 fresh samples and 13 aged samples) and 7 rejects samples that underwent mineralogical analysis by QXRD.

The samples were selected to assess a broad range of mineral waste types. The results are summarised in **Figure 5** (spoil samples) and **Figure 6** (tailings and rejects samples). Most samples are dominated by clay, quartz minerals (silicate group minerals) and non-crystalline (amorphous) material, variable contributions of carbonate and other silicate minerals.

Figure 5. Mineral distribution within spoil samples

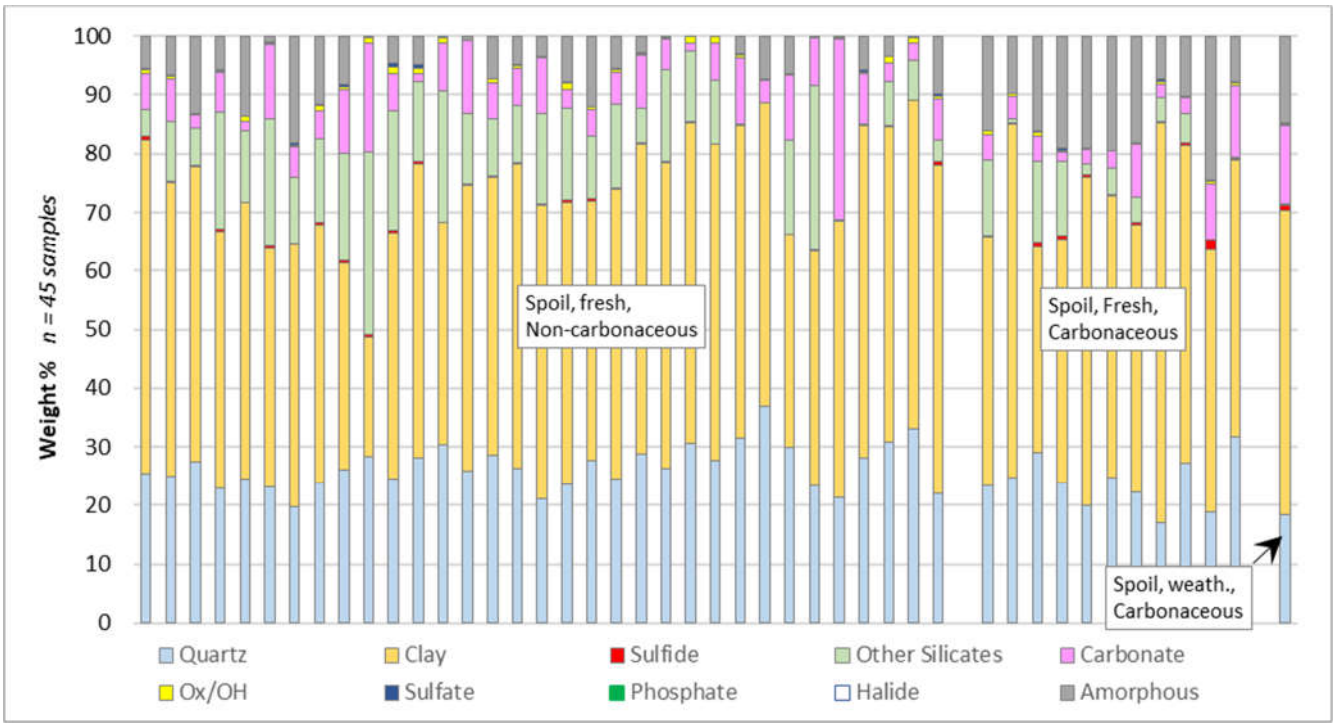
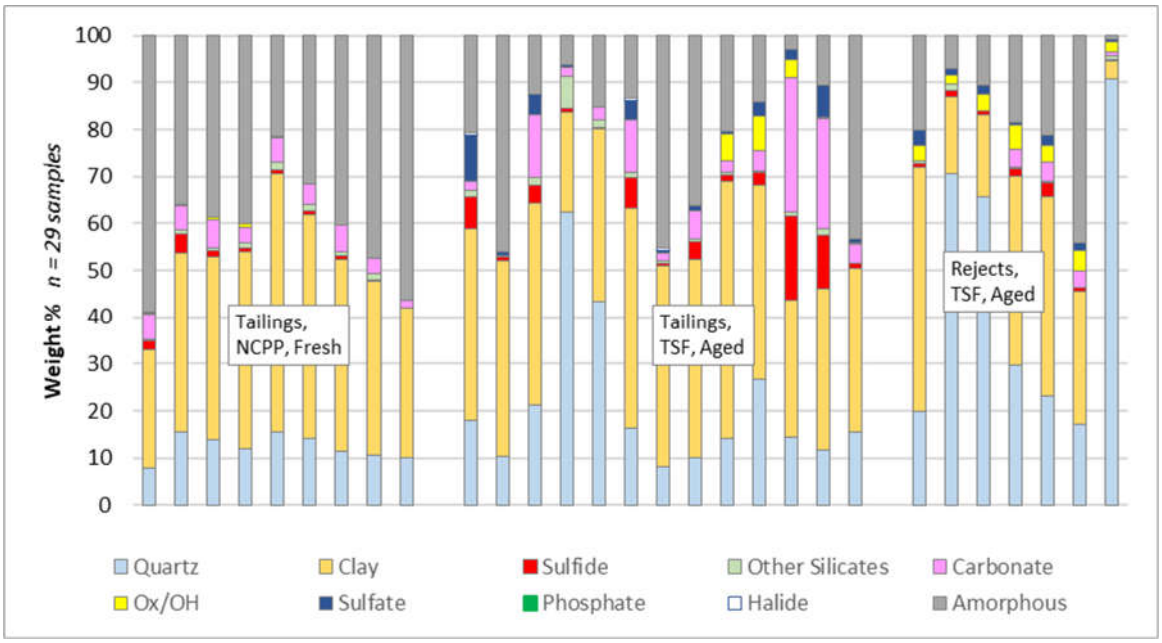


Figure 6. Mineral distribution within tailings and rejects samples



Most spoil samples have low sulfide mineral proportions as expected (median = 0.3%). Sulfide, where present, is present as pyrite and marcasite. Spoil samples have low sulfate concentrations ranging from less than 0.1% to 0.7% (median=0.2%) and tailings and rejects have slightly higher sulfate concentrations ranging from less than 0.1% to 9.9% (median = 0.5%). In spoil, the sulfate is mostly present as jarosite. In rejects the sulfate is a combination of jarosite and gypsum; and in tailings a combination of jarosite, gypsum, anhydrite and barite. The combination of jarosite and gypsum (+/- anhydrite) minerals in rejects and tailings is likely an indication of sulfide oxidation and naturalisation.

Amorphous (non-crystalline) material was detected in all samples, but generally present in greater proportions in the tailings and rejects samples (median = 21%) and carbonaceous spoil samples (median = 16%) compared to the non-carbonaceous spoil (median = 5%). The nature of the non-crystalline material is largely unknown, although for tailings, rejects and carbonaceous waste it is likely associated with organic carbon.

One carbonaceous 'spoil' sample – a seam roof sample – has high sulfide (pyrite) concentration (1.8%) and was specifically selected for mineralogical test-work because of its' high total S concentration. Given the proximity of this sample to coal, it's likely that this sample would be mined as part of ROM coal and, therefore, is likely to represent 'potential' reject more so than spoil. That is, this sample is likely representative of rejects and not typical spoil.

The tailings and rejects samples generally have higher sulfide concentrations compared to the spoil samples (median = 0.9% for tailings fresh and rejects aged; and median = 2.8% for tailings aged). Most fresh tailings samples have negligible sulfate concentrations. Comparatively, the aged tailings and rejects samples had higher sulfate concentrations, suggesting sulfide oxidation has occurred.

Across all material types, carbonate group minerals predominantly comprised calcite, ankerite (Fe-dolomite), siderite and rhodochrosite in variable proportions.

In summary, across all mineral types assessed, the key acid generating minerals are pyrite, marcasite and, to lesser extent, jarosite. The key acid neutralising minerals are iron-dolomite/dolomite and calcite. Although siderite is a carbonate, it provides no net acid neutralising capacity.

5.2 Acid-Base Accounting (Potential for AMD)

Acid-base accounting (ABA) is a theoretical balance between the potential for a sample to generate acid and neutralise acid, and is expressed in units of kilograms of sulfuric acid per tonne of sample (kg H_2SO_4/t). The ABA results for the spoil, tailings, rejects and coal samples that underwent geochemical characterisation are statistically summarised in **Table 12** (spoil) and **Table 13** (tailings, rejects and coal samples) and discussed in the following sections.

Table 12. ABA results statistics for spoil samples

		Total S[1]	Scr[2] (S)	ANC	MPA[3]	NAPP	ANC/MPA	NAGpH[4]
		%		kg H_2SO_4/t			ratio	pH units
Spoil Weath[5]., non-carb[6].	Count (*n*)	*657*	*239 (239)*	*657*	*657*	*657*	*657*	*70*
	Maximum	0.69	0.69 (0.69)	408	21	18	2266	10.0
	95th percentile	0.06	0.05 (0.13)	81	1.9	0.6	331	7.8
	75th percentile	0.02	0.02 (0.03)	21	0.6	-1.9	67	6.7
	Median	**0.01**	**0.01 (0.02)**	**7.2**	**0.3**	**-6.5**	**20**	**6.2**
	25th percentile	<0.01	<0.01 (0.01)	2.5	<0.3	-20	4.9	5.8
	5th percentile	<0.01	<0.01 (<0.01)	<0.5	<0.3	-80	0.4	4.6
	Minimum	<0.01	<0.01 (<0.01)	<0.5	<0.3	-406	<0.1	3.0
Spoil Weath., carb.	Count (*n*)	*9*	*8 (8)*	*9*	*9*	*9*	*9*	*5*
	Maximum	1.52	0.94 (1.52)	135	47	35	147	6.4
	95th percentile	1.19	0.80 (1.23)	89	36	24	96	6.4
	75th percentile	0.43	0.39 (0.50)	19	13	2.6	2.8	6.2
	Median	**0.38**	**0.13 (0.39)**	**14**	**12**	**-6.9**	**1.6**	**4.6**
	25th percentile	0.17	0.09 (0.18)	11	5.2	-10	0.8	3.7
	5th percentile	0.02	0.03 (0.07)	9.9	0.7	-85	0.4	2.7
	Minimum	0.02	0.01 (0.02)	9.0	0.6	-134	0.2	2.5
Spoil Fresh, non-carb.	Count (*n*)	*3515*	*1195 (1195)*	*3515*	*3515*	*3515*	*3515*	*104*
	Maximum	1.84	1.67 (1.84)	842	56	44	3546	11.2
	95th percentile	0.10	0.13 (0.18)	204	3.1	-12	389	10.6
	75th percentile	0.04	0.03 (0.05)	79	1.2	-25	121	8.8
	Median	**0.03**	**0.02 (0.03)**	**48**	**0.9**	**-47**	**61**	**7.6**
	25th percentile	0.02	0.02 (0.02)	26	0.6	-78	31	4.6
	5th percentile	<0.01	0.01 (0.01)	13	<0.3	-204	8.1	2.8
	Minimum	<0.01	<0.01 (<0.01)	<0.5	<0.3	-842	<0.1	2.6
Spoil Fresh, Carb.	Count (*n*)	*283*	*189 (189)*	*283*	*283*	*283*	*283*	*86*
	Maximum	2.58	1.79 (2.58)	300	79	61	456	9.4
	95th percentile	0.53	0.51 (0.72)	89	16	3.6	70	8.4
	75th percentile	0.25	0.20 (0.32)	35	7.5	-7.3	16	7.4
	Median	**0.12**	**0.10 (0.18)**	**20**	**3.7**	**-15**	**5.9**	**5.1**
	25th percentile	0.04	0.04 (0.12)	13	1.2	-30	2.6	3.8
	5th percentile	0.02	0.02 (0.03)	5.6	0.6	-78	0.7	2.6
	Minimum	<0.01	0.01 (0.01)	<0.5	<0.3	-296	<0.1	2.3
Spoil ALL	Count (*n*)	*4464*	*1631 (1631)*	*4464*	*4464*	*4464*	*4464*	*265*
	Maximum	2.58	1.79 (2.58)	842	79	61	3546	11.2
	95th percentile	0.15	0.22 (0.35)	185	4.6	-1.4	362	10.0
	75th percentile	0.04	0.04 (0.07)	72	1.2	-19	110	7.8
	Median	**0.02**	**0.02 (0.03)**	**38**	**0.6**	**-37**	**51**	**6.4**
	25th percentile	0.02	0.02 (0.02)	20	0.6	-70	21	4.6
	5th percentile	<0.01	0.01 (<0.01)	3.4	<0.3	-183	2.0	2.8
	Minimum	<0.01	<0.01 (<0.01)	<0.5	<0.3	-842	<0.1	2.3

[1] Total S values less than laboratory limit of reporting (LOR) were assigned a value of 0.5xLOR for statistical calculations.
[2] Scr was generally measured on potential spoil samples with total S greater than 0.1%. Values in parentheses are the total S statistics for samples with Scr results.
[3] MPA calculated from total S. [4] NAGpH is final pH as NAG single addition and/or NAG extended and/or Stage 1 Seq. NAG. NAG tests were generally undertaken on samples assigned a preliminary PAF, PAF-LC, UC(PAF) or 'Uncertain' classification.
[5] Weath.: weathered; [6] Carb.: carbonaceous.

Table 13. ABA results statistics for tailings, rejects and coal samples

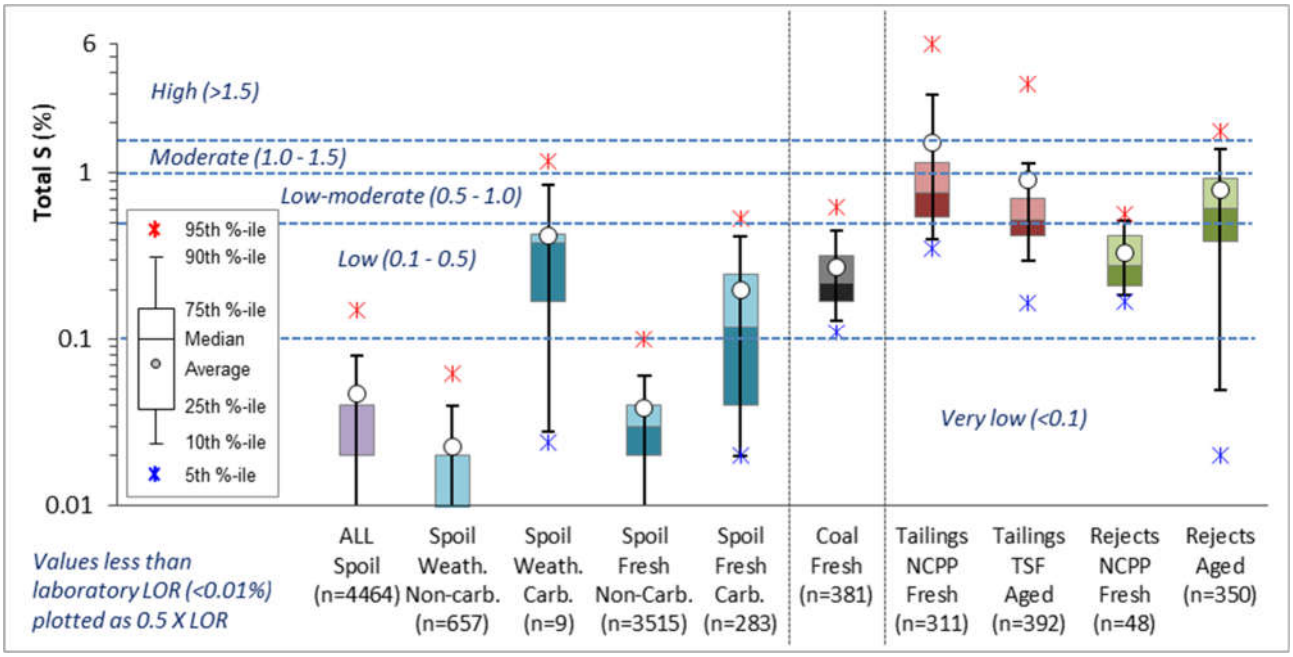
		Total S[1]	Scr[2] (S)	ANC	MPA[3]	NAPP	ANC/MPA	NAGpH[4]
		%		kg H_2SO_4/t			ratio	pH units
Tailings Fresh.	Count (*n*)	*311*	*309 (309)*	*309*	*311*	*309*	*309*	*293*
	Maximum	20.5	16.3 (20.5)	129	628	583	6.6	9.8
	95th percentile	5.93	5.30 (5.96)	65	181	110	3.2	9.0
	75th percentile	1.17	0.85 (1.17)	41	36	6.6	1.9	8.3
	Median	**0.76**	**0.54 (0.76)**	**32**	**23**	**-6.2**	**1.3**	**6.5**
	25th percentile	0.55	0.32 (0.55)	25	17	-16	0.8	3.4
	5th percentile	0.36	0.17 (0.35)	16	11	-29	0.3	2.5
	Minimum	0.20	0.08 (0.20)	<0.5	6.1	-54	<0.1	1.8
Tailings Aged	Count (*n*)	*392*	*348 (348)*	*390*	*392*	*390*	*390*	*130*
	Maximum	19.1	16.9 (19.1)	236	585	578	88	9.6
	95th percentile	3.44	1.93 (3.45)	35	105	54	2.7	6.8
	75th percentile	0.71	0.38 (0.70)	21	22	9.0	1.4	3.7
	Median	**0.52**	**0.24 (0.52)**	**16**	**16**	**1.8**	**0.9**	**3.1**
	25th percentile	0.42	0.15 (0.43)	10	13	-5.2	0.5	2.7
	5th percentile	0.17	0.03 (0.19)	2.0	5.1	-15	<0.1	2.3
	Minimum	0.02	<0.01 (0.03)	<0.5	0.6	-208	<0.1	1.9
Rejects Fresh	Count (*n*)	*48*	*48 (48)*	*48*	*48*	*48*	*48*	*48*
	Maximum	0.78	0.63 (0.78)	86	24	-1.3	17	9.4
	95th percentile	0.57	0.47 (0.57)	77	17	-7.8	8.6	9.3
	75th percentile	0.42	0.34 (0.42)	47	13	-24	5.7	8.8
	Median	**0.28**	**0.20 (0.28)**	**40**	**8.6**	**-29**	**4.4**	**8.6**
	25th percentile	0.21	0.14 (0.21)	34	6.4	-37	2.8	8.4
	5th percentile	0.17	0.10 (0.17)	20	5.2	-64	2.0	7.9
	Minimum	0.14	0.05 (0.14)	13	4.3	-81	1.1	6.3
Rejects Aged	Count (*n*)	*350*	*309 (309)*	*350*	*350*	*350*	*350*	*181*
	Maximum	8.93	7.19 (8.93)	104	273	234	101	9.2
	95th percentile	1.79	1.47 (1.92)	56	55	39	12	8.7
	75th percentile	0.93	0.65 (0.96)	30	28	9.8	2.0	7.8
	Median	**0.61**	**0.32 (0.64)**	**18**	**19**	**-3.6**	**1.2**	**6.0**
	25th percentile	0.39	0.07 (0.40)	7.8	12	-9.8	0.5	3.6
	5th percentile	0.02	0.01 (0.02)	<0.5	0.6	-30	<0.1	2.7
	Minimum	<0.01	<0.01 (<0.01)	<0.5	<0.3	-90	<0.1	2.1
Coal Fresh	Count (*n*)	*381*	*368 (368)*	*381*	*381*	*381*	*381*	*213*
	Maximum	1.60	1.12 (1.60)	339	49	41	158	11.1
	95th percentile	0.62	0.36 (0.63)	94	19	7.7	12	8.3
	75th percentile	0.32	0.09 (0.32)	20	9.8	-0.2	2.8	6.1
	Median	**0.22**	**0.03 (0.22)**	**11**	**6.7**	**-3.5**	**1.5**	**3.6**
	25th percentile	0.17	0.02 (0.17)	7.4	5.2	-11	1.0	2.8
	5th percentile	0.11	<0.01 (0.11)	0.6	3.4	-85	0.1	2.4
	Minimum	0.02	<0.01 (0.02)	<0.5	0.6	-337	<0.1	2.2

[1] Total S values less than laboratory limit of reporting (LOR) were assigned a value of 0.5xLOR for statistical calculations.
[2] Scr was generally measured on most tailings, rejects and coal samples. Values in parentheses are the total S statistics for samples with Scr results.
[3] MPA calculated from total S. [4] NAGpH is final pH as NAG single addition and/or NAG extended and/or Stage 1 Seq. NAG.

Sulfur and sulfide

The total sulfur (total S) distribution for all samples is presented in **Figure 7**. The total S concentration of spoil samples was generally very low to low – with a very low median value of 0.02% and low 95th percentile value of 0.15%. Carbonaceous spoil samples had higher total S values compared to non-carbonaceous spoil. Of the 4464 spoil samples, six samples (approximately 0.1% of all spoil samples) had high total S values (greater than 1.5%) and all were closely associated with seams (i.e. parting or thicker interburden between plys).

Figure 7. Sulfur (S) distribution



Total S concentration of most rejects and tailings samples was generally higher than most spoil samples (as expected) and also generally higher than most coal samples. NCPP tailings (fresh tailings) had slightly higher total S concentration overall compared to aged tailings samples from the TSFs. Comparatively, the total S concentration of the aged rejects from TSFs and reject dumps was higher compared to NCPP rejects (fresh rejects). Total S concentration within the aged tailings is generally consistent with depth and spatial distribution throughout the TSFs where samples were collected. Therefore, differences between total S in fresh (NCPP) tailings versus aged (TSF) tailings is likely due to ROM coal geochemistry. The reasons for aged rejects having higher total S concentration (generally) compared to fresh rejects – where the opposite occurs with aged and fresh tailings – is unclear, although is likely due to ROM coal geochemistry.

Coal samples selected for test-work had relatively low total S values, with median, 75th and 95th percentile total S values of 0.22%, 0.32%, and 0.62%, respectively. This sample subset has a total S distribution statistically equivalent to that of the larger BWM coal quality database. In particular, the 7495 coal samples from the BWM coal quality database have median, 75th and 95th percentile total S values of 0.39%, 0.48% and 0.67%, respectively. Thus, the total S distribution in coal from the smaller geochemical dataset (n=381) is broadly comparable to the total S distribution in coal from the much larger coal quality dataset (n=7495).

Chromium reducible sulfur (Scr) data is available for 1631 spoil samples, 657 tailings samples, 357 rejects samples and 368 coal samples. Scr was generally measured on samples with total S values greater than 0.1%. Where sulfide was measured in weathered samples, this was generally only in those

samples described as being 'slightly' weathered. The total S and Scr distribution for spoil samples is shown at **Figure 8** and for coal, tailings and rejects samples at **Figure 9**. Only total S values are shown for the same samples that underwent Scr tests.

Figure 8. Sulfur (S) and sulfide (Scr) distribution of spoil samples

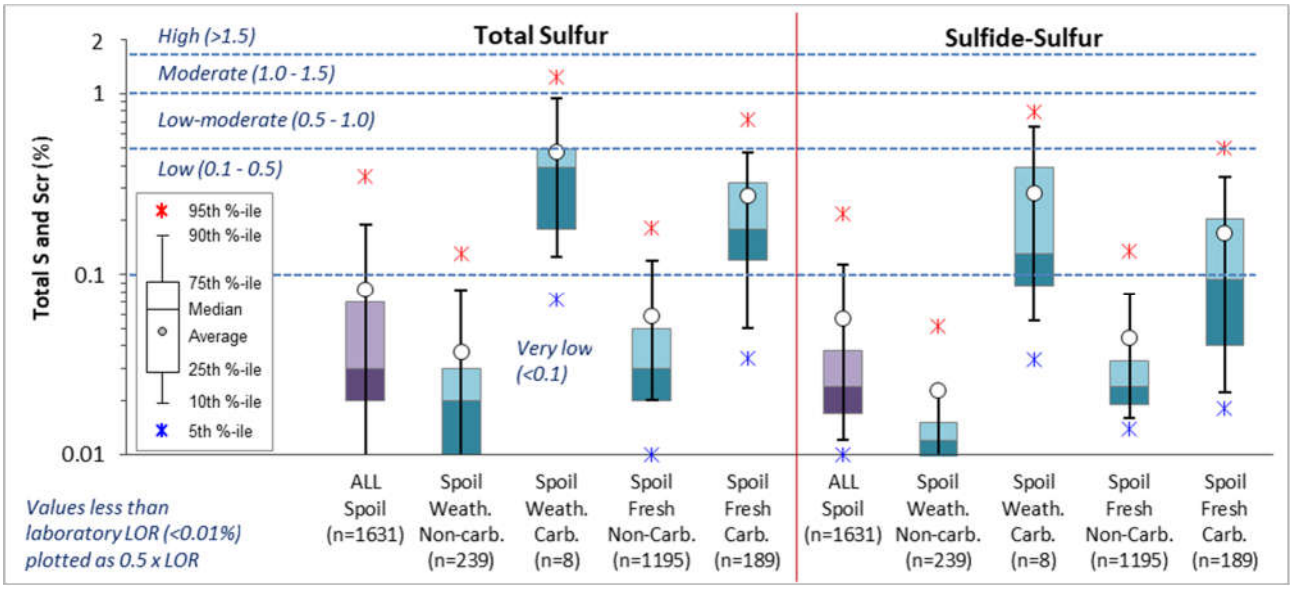
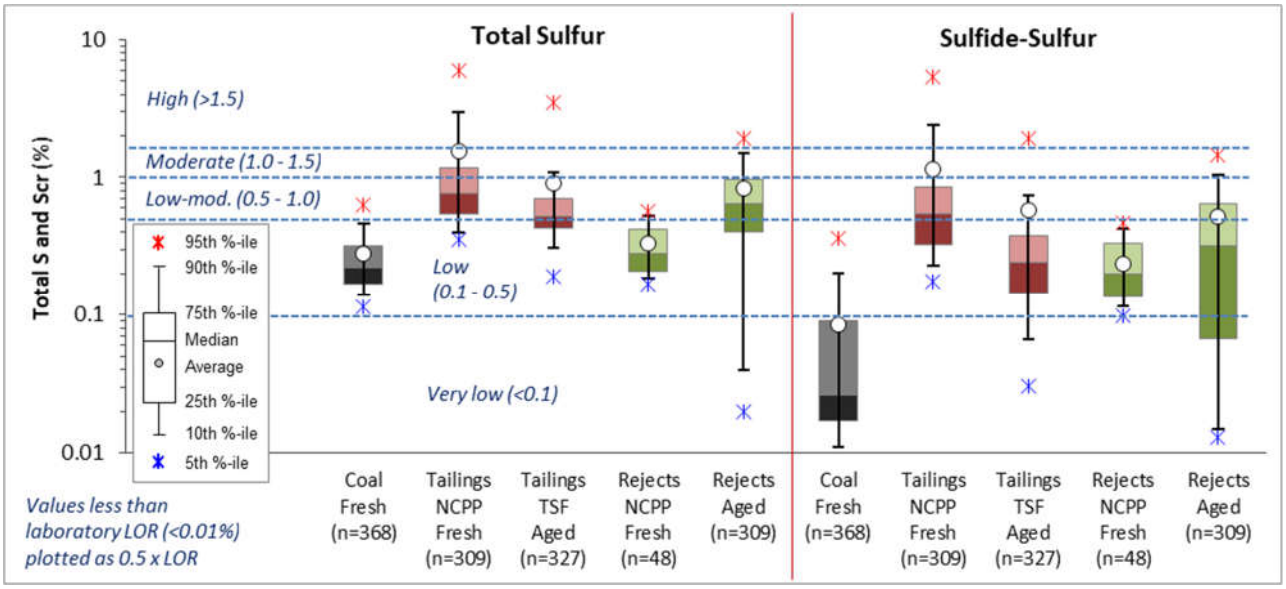


Figure 9. Sulfur (S) and sulfide (Scr) distribution of coal, tailings and rejects samples



Most spoil samples had Scr distributions only marginally lower than the total S distributions from the same group of samples. The Scr values for coal samples were generally lower compared to the total S values from the same samples.

Fresh (NCPP) tailings and rejects samples have Scr values only marginally lower than the total S values from the same samples. Comparatively, the Scr values for aged tailings and rejects are much lower, generally, than the total S values from the same samples – suggesting that the aged tailings and rejects samples have likely oxidised to some extent.

Scr as a proportion of total S for each material type is shown in **Table 14**. For the non-carbonaceous spoil samples, Scr accounts for most of the total S (83% to 87%, median value). Comparatively, the

carbonaceous spoil samples have a lower proportion of Scr (61% to 63% median value) due to a greater proportion of these samples likely containing organic sulfur, compared to the non-carbonaceous samples (of which most were fresh and unoxidised). Total S in the coal samples is expected to be mostly present as organic S, as evident by the low proportion of Scr (14%, median value).

Table 14. Scr as a proportion of total S

Material	Scr as a % of total S (median value)	Material	Scr as a % of total S (median value)
Spoil, weathered, non-carb. (n=239)	83%	Tailings, fresh, NCPP (n=308)	69%
Spoil, fresh, non-carb. (n=1195)	87%	Rejects, fresh, NCPP (n=48)	74%
Spoil, weathered, carb. (n=8)	61%	Tailings, aged (n=348)	48%
Spoil, fresh, carb. (n=189)	63%	Rejects, aged (n=309)	59%
ALL Spoil (n=1631)	85%	Coal (n=368)	14%

As a proportion of total S, Scr accounts for 69% (median value) of total S in fresh (NCPP) tailings samples and 74% in fresh (NCPP) rejects samples. Comparatively, as a proportion of total S, Scr accounts for 48% (median value) in aged tailings and 59% in aged rejects samples.

These results indicate that using total S as an indication of AMD hazard for all samples – but especially those samples containing a greater proportion of carbonaceous and coaly material – will result in a conservative outcome. For the aged tailings and rejects samples, and the weathered carbonaceous spoil samples, it is highly likely that some of the sulfide that may have been originally present in these aged samples when they were fresh has oxidised to sulfate.

Maximum potential acidity (MPA)

MPA is calculated from total S, therefore the MPA distribution for each material type mimics the total S distribution for the same samples (refer to **Figure 7**). Due to the generally very low to low total S (and Scr) values for spoil samples the MPA was correspondingly low, with 75th and 95th percentile MPA values of 1.2 and 4.6 kg H_2SO_4/t, respectively (n=4464 samples). As such, spoil represented by these samples is expected to have negligible potential to generate acid/acidity and negligible potential to release sulfate-derived salinity from sulfide oxidation. The small proportion of spoil with higher' MPA (as a result of the higher total S) would be well mixed throughout the bulk spoil and, as such, would not lead to spoil generating acid/acidity or sulfate-derived salinity.

Coal samples (n=381) produced MPA values generally higher than spoil – as expected by the higher total S values of coal samples. Coal samples had 75th and 95th percentile MPA values of 9.8 and 19 kg H_2SO_4/t, respectively. As discussed above, the proportion of total S associated with sulfide minerals in coal samples is low (14% of total S as Scr), with most sulfur likely associated with organic sulfur. Therefore, MPA values calculated from total S for coal samples is very conservative. By way of comparison, the 95th percentile MPA value for coal samples calculated from Scr (n=368) is 11 kg H_2SO_4/t – i.e. about 58% of the 95th percentile MPA value calculated from total S.

Tailings and rejects had a wide range of total S values – ranging from low to moderate – depending on the material sub-type, which resulted in a correspondingly wide range of MPA values. For example, fresh (NCPP) tailings had a 75th percentile MPA of 36 kg H_2SO_4/t (n=311 samples). Comparatively, aged tailings had a slightly lower 75th percentile MPA of 22 kg H_2SO_4/t (n=392). Fresh (NCPP) rejects had a 75th percentile MPA of 13 kg H_2SO_4/t (n=48) whereas aged rejects had a much higher 75th percentile MPA of 28 kg H_2SO_4/t (n=350).

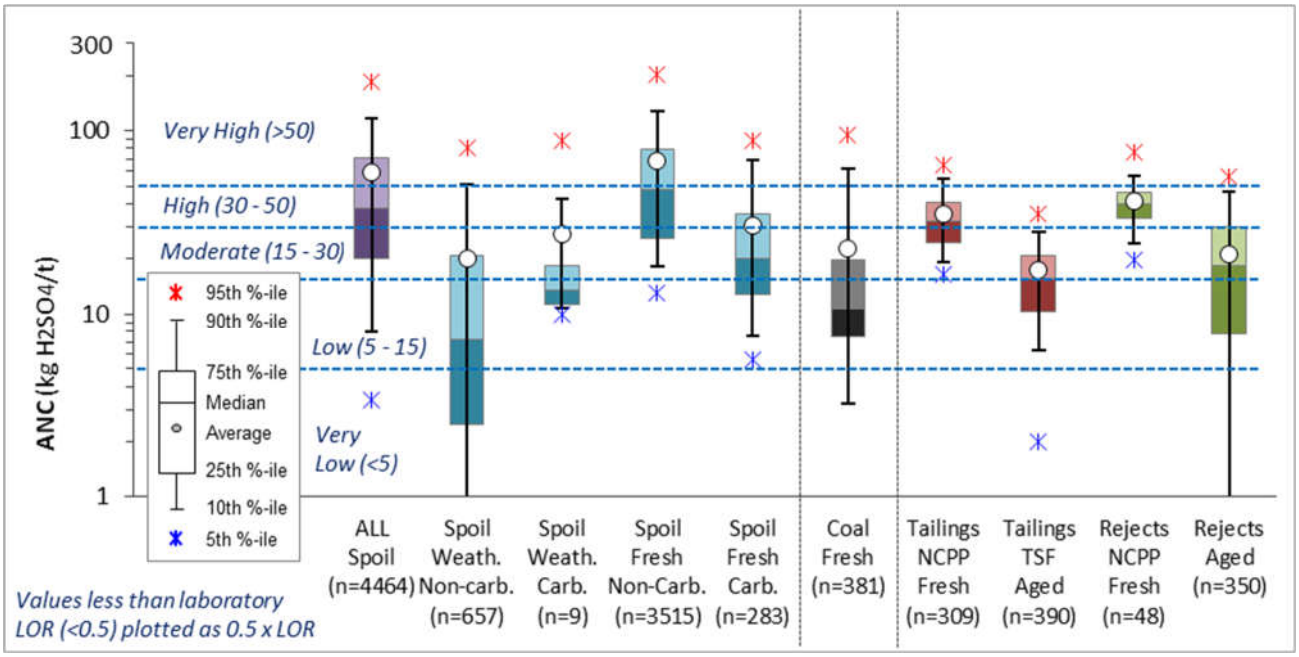
Acid neutralising capacity (ANC)

The ANC distribution for all samples is presented in **Figure 10**. The ANC values of spoil samples are typically well in excess of the MPA values and span a very large range, from less than 0.5 to 842 kg H_2SO_4/t, with a high median and 10th percentile ANC value for spoil samples of 38 kg H_2SO_4/t and 8.0 kg H_2SO_4/t, respectively. In other words, 90% of spoil samples have an ANC greater than 8.0 kg H_2SO_4/t which, if all ANC was readily available, would neutralise the acidity generated by material containing 0.26% S.

The ANC for the fresh (NCPP) tailings samples was generally moderate to high and for fresh (NCPP) rejects samples was generally high, with 10th percentile values of 19 and 25 kg H_2SO_4/t for fresh tailings and fresh rejects, respectively. Comparatively, aged tailings had generally low to moderate ANC distribution with a 10th percentile value of 6.3 kg H_2SO_4/t. Aged rejects had a wide range of ANC values – generally from very low to high.

Coal samples also had a wide range of ANC values from very low to high, but low to moderate overall with median and 10th percentile ANC values of 11 and 3.2 kg H_2SO_4/t, respectively.

Figure 10. Acid neutralising capacity (ANC) distribution



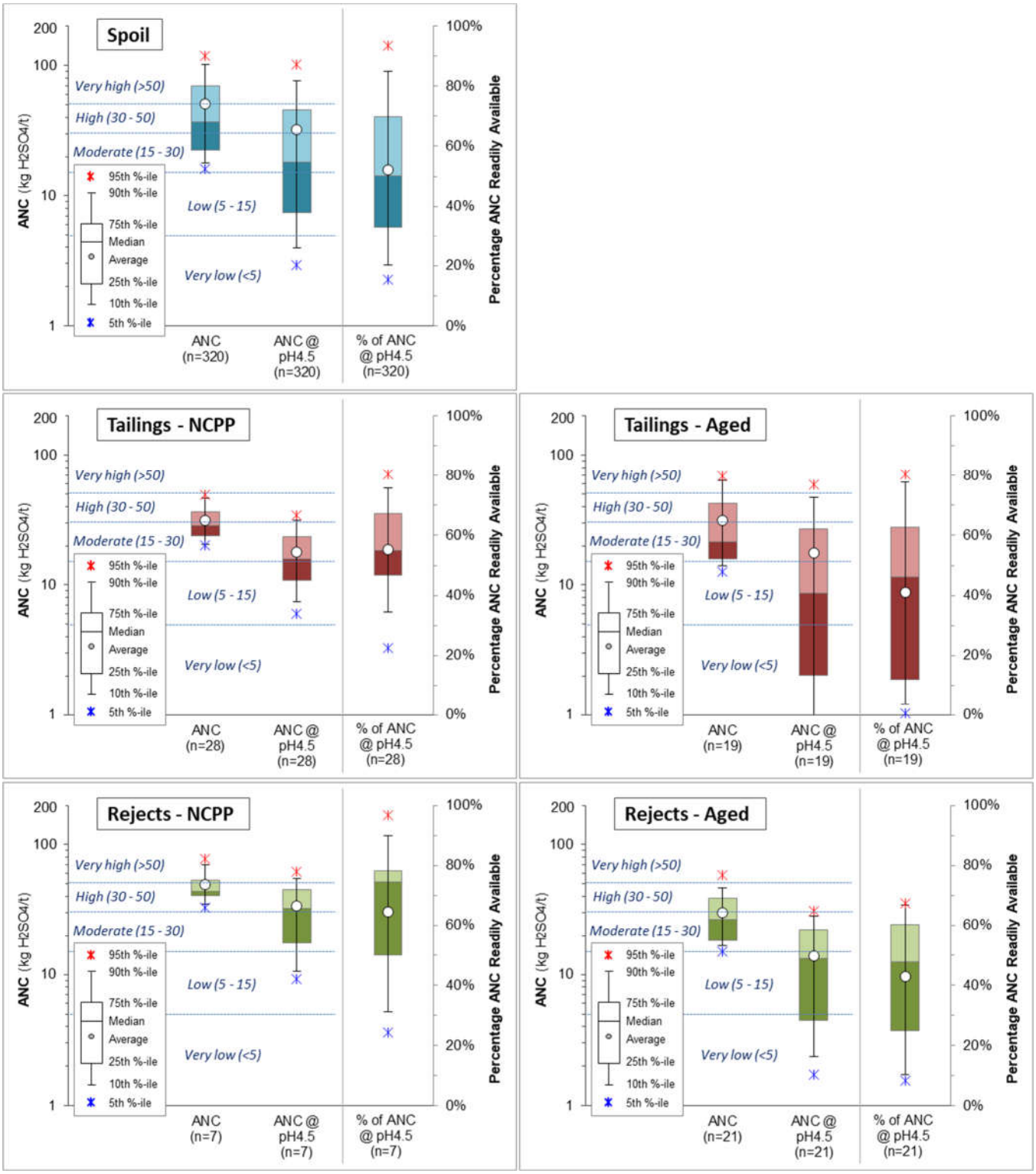
Available acid neutralising capacity

The availability of neutralising material is generally determined by the mineralogy of the sample – with calcite and dolomite (carbonate minerals) being more readily-available to neutralise acidity compared with, for example, silicates. Siderite, although a carbonate, has no net acid neutralising capacity. As such, ANC assumes that all ANC is readily available to neutralise acid, when this is rarely the case. Hence, ABCC (and mineralogical) test-work is undertaken to understand the effective ANC.

Acid buffering characterisation curve (ABCC) tests were undertaken on 320 spoil samples, 28 fresh (NCPP) tailings samples, 7 fresh (NCPP) rejects samples, 19 aged tailings samples and 21 aged rejects samples. ABCC results are used to assess the proportion of ANC that may be 'readily available' (i.e. short-acting) in these materials under field conditions and provide some indication of what carbonate minerals are providing the ANC. 'Ready availability' is regarded as the proportion of ANC that is

available for buffering reaction at pH 4.5. The results are summarised in Figure 11 for spoil, tailings and rejects samples.

Figure 11. Distribution of acid neutralising capacity (ANC) [total], ANC at pH4.5 and proportion (%) of ANC expected to be readily available



For the 320 spoil samples where ABCC data is available, the results showed that the proportion of ANC likely available under field conditions ranged from about 6% to nominally 100% of the ANC, with a median of approximately 50%. The results – based on the 25th and 75th percentile values – suggest that

about 33% to 70% of the ANC is expected to be available under field conditions from spoil material – which is typical for spoil material from the Bowen Basin.

For the fresh tailings and rejects samples, the results showed that the proportion of ANC likely available under field conditions ranged from approximately 20-90% of the ANC, but overall (and based on the 25th and 75th percentile values), about 50-75% of the ANC is expected to be available under field conditions – fairly typical for fresh tailings and rejects from the Rangal Coal Measures.

Comparatively, the availability of ANC under field conditions for the aged tailings and rejects samples is very broad – ranging from essentially zero to about 85% – suggesting that the amount of ANC that may have already been consumed in the aged samples varies considerably.

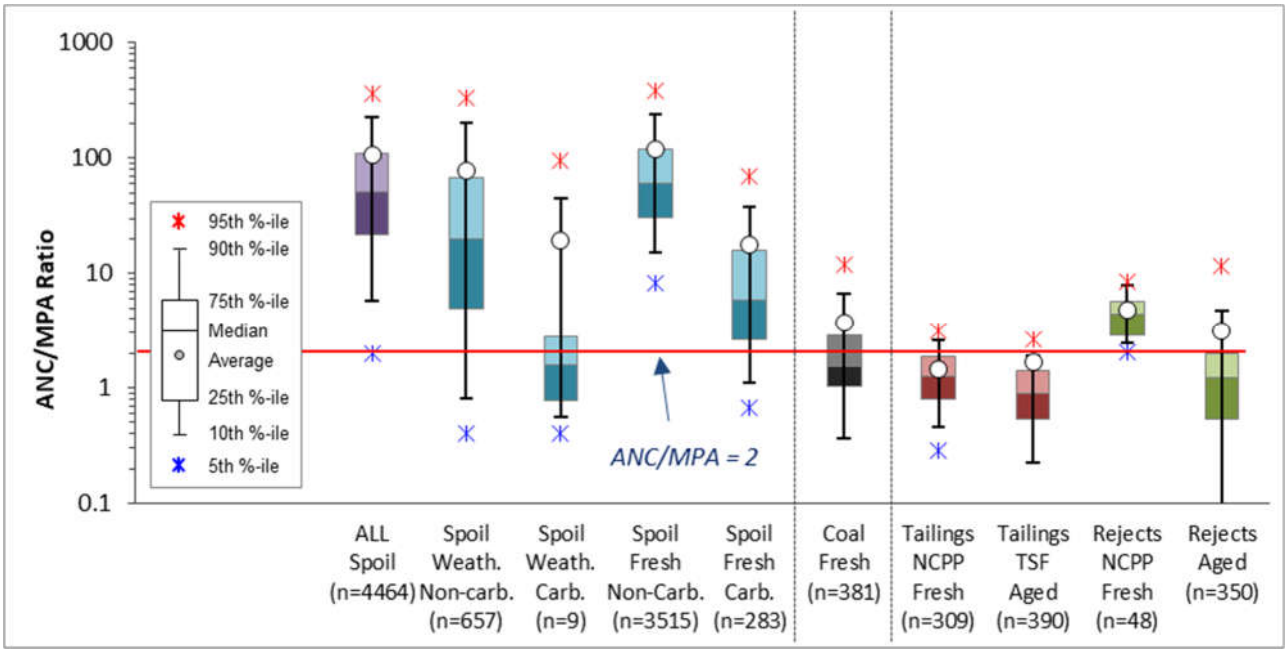
ANC / MPA ratio

Generally, those samples with an ANC/MPA ratio greater than two are considered to have a negligible/low risk of acid generation (DIIS, 2016; INAP, 2009[3]), especially where sulfide concentrations are very low and reactive ANC is moderate to high – as is the case with the potential spoil samples. The results, illustrated in **Figure 12**, show that:

- Ninety-nine per cent (95%) of 4464 spoil samples have an ANC/MPA ratio greater than two – noting that 79% of all spoil samples are fresh non-carbonaceous. Approximately 80% of fresh carbonaceous spoil samples (227 out of 283 samples) have an ANC/MPA ratio greater than two.
- Eighty-five percent (85%) of all tailings samples (597 of 699 samples) had ANC/MPA ratios less than or equal to two.
- Most of (76% of) the aged rejects samples had ANC/MPA ratios less than or equal to two. Comparatively, most of (94% of) the fresh (NCPP) rejects samples have ANC/MPA ratios greater than two.
- Sixty-one per cent (61%) of all coal samples had ANC/MPA ratios less than or equal to two.

3 INAP (2009) considers that mine materials with an ANC/MPA ratio greater than two are likely to be NAF unless significant preferential exposure of sulfide minerals occurs along fracture planes, in combination with insufficiently reactive ANC.

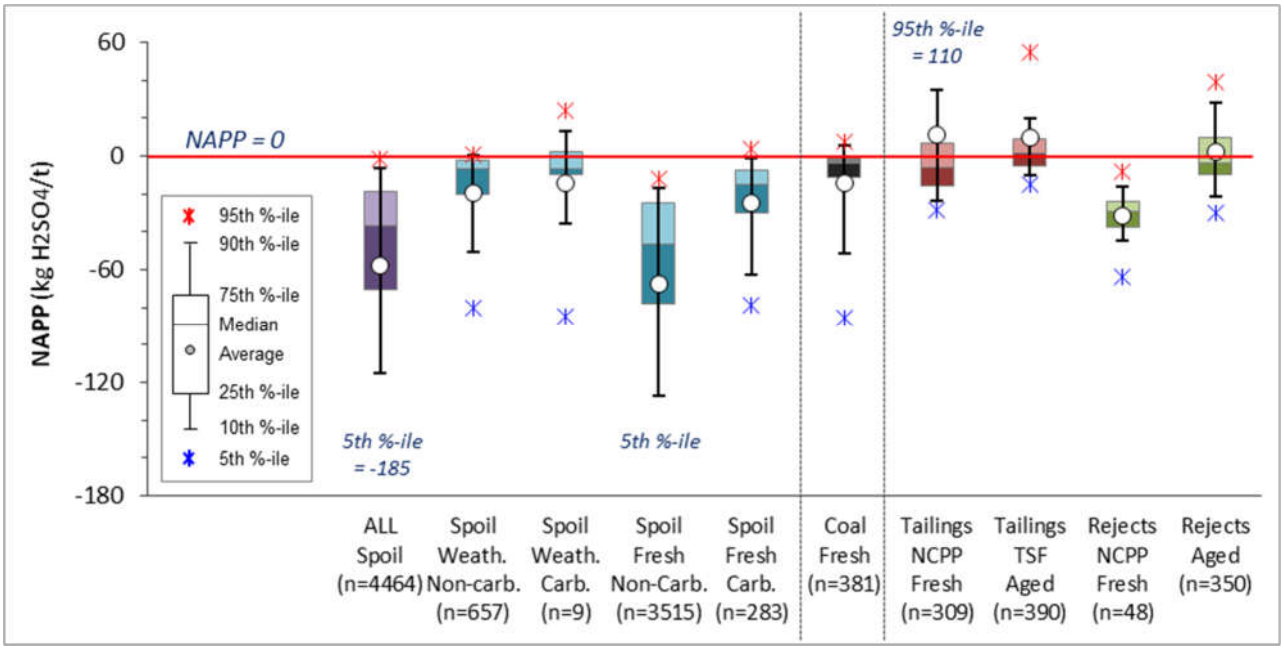
Figure 12. Distribution of the ratio of acid neutralising capacity (ANC) to maximum potential acidity (MPA) [ANC/MPA ratio]



Net acid producing potential (NAPP)

The NAPP distribution for all samples is presented in **Figure 13**. Based on the generally low MPA and higher ANC values (relative to the MPA), the calculated NAPP values are negative for the large majority of spoil samples. The results indicate that, overall, there is significantly excess neutralising capacity (ANC) compared to potential acidity (MPA) for spoil samples.

Figure 13. Distribution of net acid producing potential (NAPP)



Tailings samples (fresh and aged, combined) have a wide range of NAPP values from -24 to 104 kg H_2SO_4/t (5th and 95th percentile values, respectively), but overall range from low negative to low positive NAPP values (25th and 75th percentile values of -9.6 and 8.5 kg H_2SO_4/t, respectively). A similar trend

was observed in aged rejects samples. Comparatively, all fresh rejects samples reported negative NAPP values. As also evident in Figure 13, most of the coal samples reported negative NAPP values.

Net acid generation (NAG) capacity

NAG test results are used in conjunction with NAPP values in determining the acid classification of samples. The calculated NAPP value assumes that all sulfur (present as sulfide) will oxidise to generate acid (MPA) and that all neutralising material in a sample is in a readily available form to neutralise any acid that could be generated (ANC). Unlike the theoretical basis of the NAPP test, in a NAG test a sample is encouraged to oxidise by reaction with hydrogen peroxide and any acid generated through oxidation may be consumed by neutralising components in the sample. Any remaining acidity is measured and expressed as kg H_2SO_4/t.

Samples with NAGpH values greater than pH 4.5 are considered to be NAF. Samples with NAGpH values less than or equal to pH 4.5 (i.e. acid-generating) would also be expected to have measurable NAG capacity (i.e. NAG capacity greater than 0.1 kg H_2SO_4/t). As a guide, NAG capacity values between 0.1 and 5 kg H_2SO_4/t are considered 'low capacity' (AMIRA, 2002).

NAG test data is available for 265 spoil samples, 213 coal samples, 293 fresh tailings samples, 130 aged tailings samples, 48 fresh rejects samples, and 181 aged rejects samples with the NAGpH distribution for these samples shown in Figure 14. Of the samples tested; 77% of spoil, 59% of fresh (NCPP) tailings, 15% of aged tailings, all fresh (NCPP) rejects and 62% of aged rejects samples tested had NAGpH values greater than pH4.5. Of the coal samples, 39% had NAGpH values greater than pH4.5.

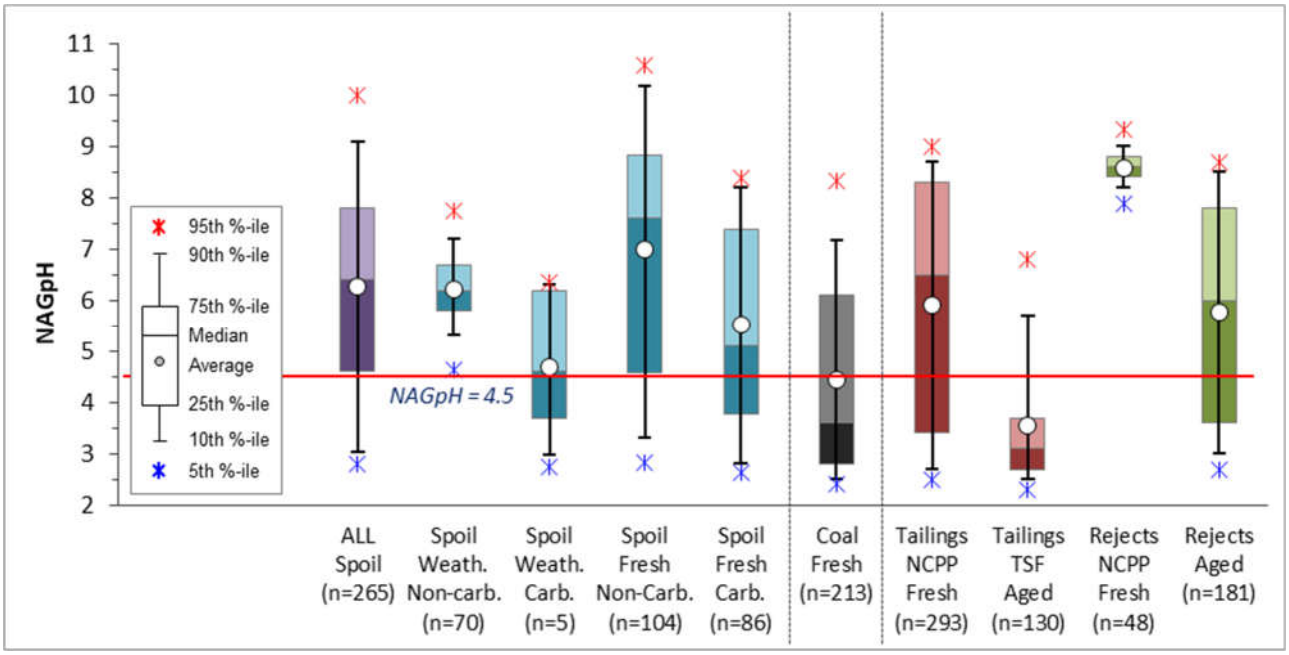
As per general practice, NAG tests tend to be undertaken on samples with higher total S values and/or those samples potentially considered to have a greater potential to generate AMD, such as samples closely associated with coal seams, or tailings and rejects samples. As such, the proportion of samples with NAGpH values less than pH4.5 is not representing the actual proportion of material in the field that can generate acid conditions, but is indicative of the type of material (based on total S and ANC concentrations) that may generate AD under field conditions.

The NAG test can be influenced by organic acid (i.e. organic acid can produce NAGpH between approximately pH 4 to 4.5, thus providing a 'false positive' for sulfuric acid). Organic acid is typically produced by samples with high organic carbon content – such as coal and highly carbonaceous samples.

To attempt to resolve some of the uncertainty with the 'single addition' NAG test for coaly and highly carbonaceous samples, 244 samples underwent an Extended Boil NAG method (NAG Extended). Samples included 204 coal, 3 non-carbonaceous spoil, 6 coaly and carbonaceous spoil, 26 tailings and five rejects samples.

Seventy (70) of these 244 samples (or 29% of samples) returned Extended NAGpH values greater than pH4.5, suggesting that for about one third of the mostly coal and tailings samples tested the acidity generated in the 'single addition' NAG test was associated with the oxidation of organic carbon and not with sulfide oxidation.

Figure 14. Distribution of net acid generation pH (NAG single or NAG Extended or Stage 1 NAG Sequential)



AMD classification

The ABA results presented in this section have been used to classify the acid forming nature of the samples following the classification criteria outlined in Section 4.4 (Table 2). Additional relevant data, such as ABCC and Extended NAG test results were used to aid in the classification of samples where there was uncertainty following the preliminary AMD classification. The acid forming nature of these samples is summarised in Table 15.

Spoil

The classifications in Table 15 show that 98% of spoil samples were classified as NAF or were expected to be NAF [and have been classified as UC(NAF)]. These spoil samples and spoil material represented by these samples have very low sulfur concentration, significant excess ANC (relative to the MPA) and clearly have negligible capacity to generate AMD. Approximately 2% of spoil samples (96 out of 4464 samples) were classified as PAF, PAF-LC or UC(PAF). Three samples were classified as NAF-S.

Data show that potential spoil, as a bulk material, would be overwhelmingly NAF – and essentially all spoil away from seams (which is the overwhelming bulk of spoil) is expected to be NAF. Furthermore, the very low sulfur concentrations in spoil indicates that the sulfate concentration that could be generated in spoil from sulfide oxidation (in addition to any salinity unrelated to sulfide oxidation) would also be very low.

PAF spoil is mostly closely associated with seams, as seam roof, parting or floor, which may largely report to a CHPP as ROM coal and leave the CHPP as rejects. PAF spoil is also likely to be associated with thicker interburden zones between seam plys of the same seam group. That is, PAF spoil is rarely encountered well away from seams.

Table 15. Geochemical classification of samples

Material Type	NAF	UC(NAF)	NAF-S	UC(PAF)	PAF-LC	PAF
	Number and (%) of samples					
Spoil, weath, non-carb. (n=657)	586 (89%)	43 (6.5%)	-	1 (<0.2%)	27 (4.1%)	-
Spoil, weathered carbonaceous (n=9)	6 (67%)	-	-	2 (22%)	-	1 (11%)
Spoil, fresh non-carbonaceous (n=3515)	3472 (99%)	12 (0.3%)	1 (<0.1%)	10 (0.3%)	16 (0.5%)	4 (0.1%)
Spoil, fresh carbonaceous (n=283)	242 (86%)	4 (1.4%)	2 (0.7%)	19 (6.7%)	13 (4.6%)	3 (1.1%)
Spoil [all] (n=4464)	***4306 (96%)***	***59 (1.3%)***	***3 (<0.1%)***	***32 (0.7%)***	***56 (1.3%)***	***8 (<0.2%)***
	4365 (98%)		***3 (<0.1%)***	***96 (2%)***		
Coal (n=381)	**231 (61%)**	**14 (3.7%)**	**1 (<0.3%)**	**3 (0.8%)**	**105 (28%)**	**27 (7.1%)**
	245 (64%)		***1 (<0.3%)***	***135 (35%)***		
Tailings, fresh, NCPP (n=311)	153 (49%)	15 (4.8%)	18 (5.8%)	52 (17%)	28 (9.0%)	45 (14%)
Tailings, aged, TSFs (n=392)	88 (22%)	57 (15%)	1 (0.3%)	83 (21%)	116 (30%)	47 (12%)
Tailings [all] (n=703)	***241 (34%)***	***72 (10%)***	***19 (2.7%)***	***135 (19%)***	***144 (20%)***	***92 (13%)***
	313 (45%)		***19 (<3%)***	***371 (53%)***		
Rejects, fresh, NCPP (n=48)	48 (100%)	-	-	-	-	-
Rejects, aged (n=350)	141 (40%)	29 (8.3%)	16 (4.6%)	54 (15%)	55 (16%)	55 (16%)
Rejects [all] (n=398)	**189 (47%)**	**29 (7.3%)**	**16 (4%)**	**54 (14%)**	**55 (14%)**	**55 (14%)**
	218 (55%)		***16 (4%)***	***164 (41%)***		

Tailings

Approximately 53% of 703 tailing samples were classified as UC(PAF), PAF-LC or PAF and, of these 'PAF' samples, approximately 75% were classified as UC(PAF) or PAF-LC. About 40% of fresh (NCPP) tailings samples and 63% of aged (TSF) tailings samples were classified as 'PAF' of some type. Most of the aged tailings samples were logged as moist to wet at time of collection (excluding near-surface samples), and are therefore assumed to have not been subjected to significant oxidation – assuming deeper tailings were buried by overlying tailings soon after deposition. Nineteen tailings samples (almost all from the NCPP) were classified as NAF-S.

From an acid generating perspective just over half (approximately 55%) of all tailings samples were classified as 'PAF' (of some type) or NAF-S and, therefore, pose a potential AMD source hazard with respect to AD and/or NMD/SD. The relatively high proportion of 'PAF' tailings samples classified as UC(PAF) or PAF-LC suggests that tailings, overall, are expected to generate low to moderate acidity loads if allowed to fully oxidise.

Rejects

The results show that all fresh rejects from the NCPP were classified as NAF; and approximately 49% of aged rejects were classified as NAF or UC(NAF). The remaining 51% of aged rejects had some type of broader 'PAF' classification, including 16 aged rejects samples classified as NAF-S. Therefore, from an

acid generating perspective, about half of the aged rejects pose a potential AMD source hazard with respect to AD and/or NMD/SD.

Coal

Compared to spoil, coal samples had marginally higher total S values and marginally lower ANC, which resulted in approximately 36% of coal samples being classified as PAF, PAF-LC or UC(PAF) – including one sample classified as NAF-S. The proportion of PAF, PAF-LC, UC(PAF) and NAF-S samples is comparable across all coal seam groups being mined at BWM. It is worth noting that approximately 80% of the coal samples classified as some form of 'PAF' [including the single sample classified as NAF-S] showed limited or uncertain capacity to generate acidity [classified as UC(PAF) or PAF-LC], suggesting that 'PAF' coal is unlikely to generate significant acid(ity). Furthermore, the Scr content of coal samples was generally low – comprising about 14% (median value) of the total S. This suggests that the 'PAF' (including PAF sub-groups) classification is conservative for most coal samples. On the other side of the acid-base account, it is recognised that ANC is likely an overestimate, however the AMD classification already takes this into account by assuming ANC is only 50% available (i.e. the classification uses an ANC/MPA ratio of 2).

Approximately 64% of coal samples tested (245 out of 381 samples) were classified as NAF or UC(NAF), and seam material represented by these samples has very low sulfur values, excess ANC (relative to the MPA) and clearly has no capacity to generate acidity or release significant sulfate from sulfide oxidation.

These results suggest that coal represented by these samples and stored on a ROM pad, or located within pit walls or un-economic coal seam material reporting as spoil (mixed with non-coal spoil) would likely be bulk NAF. A small proportion of coal (from all seam groups) poses a greater, but relatively low, AMD source hazard.

5.3 Total Metals and Metalloids

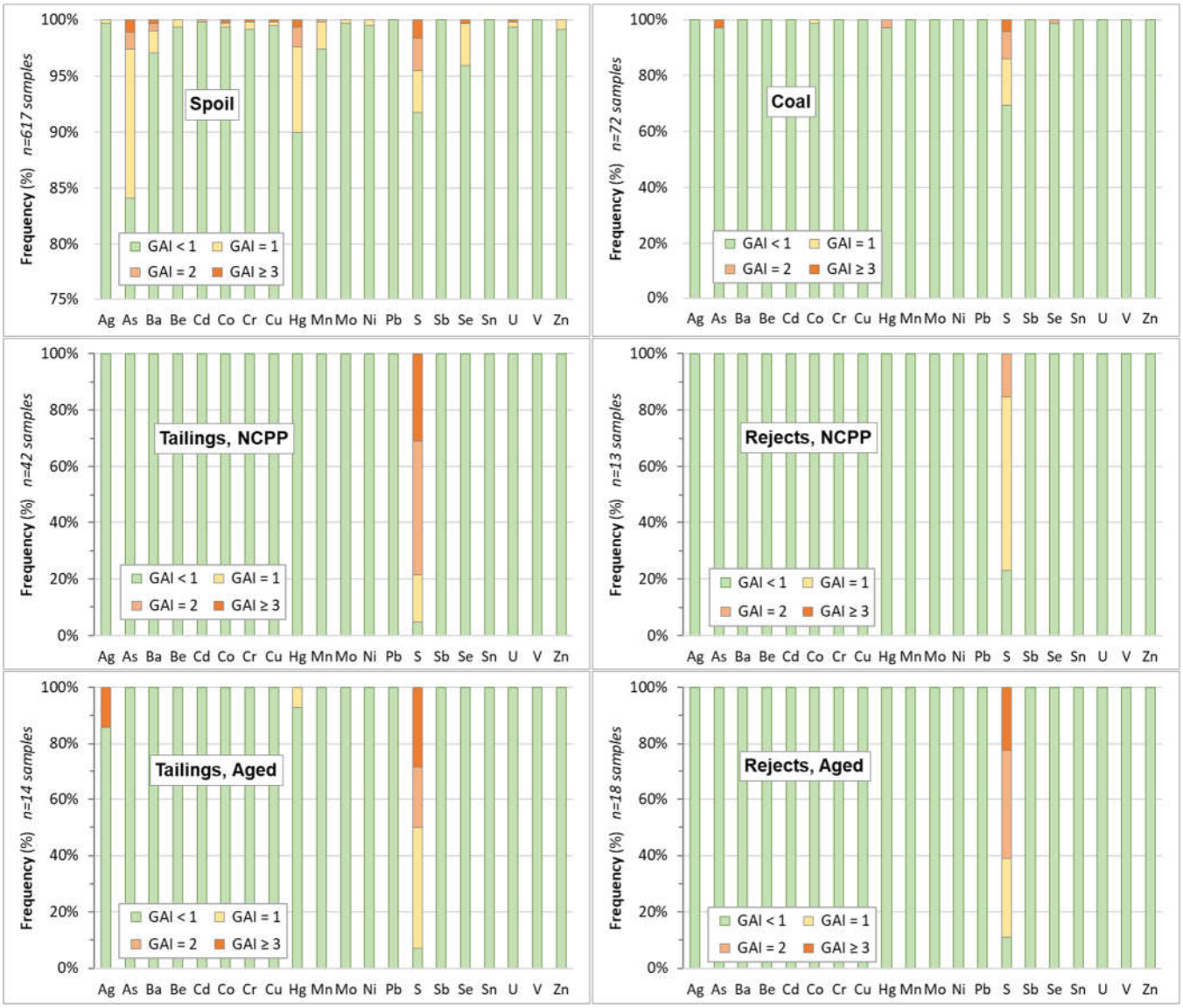
Multi-element (metal and metalloid) data is available for 776 samples, comprising 617 spoil samples [all four spoil groups represented], 72 coal samples, 31 rejects samples [13 fresh and 18 aged] and 56 tailings samples [42 fresh and 14 aged]. The degree of enrichment with respect to elements potentially of environmental interest for the spoil, coal, reject and tailings materials is shown in **Figure 15**.

The GAI values show that 26 (out of 617) spoil samples and three (out of 72) coal samples were significantly enriched [GAI ≥3] with regard to one or more of arsenic (As), barium (Ba), cobalt (Co), chromium (Cr), copper (Cu), mercury (Hg), selenium (Se), sulfur (S) and/or uranium (U). The level of S enrichment in these samples is consistent with the ABA data for these same samples. The enrichment in some elements in a small number of samples is not cause for concern.

With regard to the degree of element enrichment in tailings samples, 11 out of 42 fresh (NCPP) tailings samples and four (out of 14) aged tailings samples were significantly enriched in S, with the degree of enrichment consistent with the ABA data for these same samples. Two aged tailings samples were also significantly enriched in As. Comparatively, no fresh (NCPP) rejects samples were significantly enriched for any metals or metalloids. Four out of 17 aged rejects samples were significantly enriched with regard to S.

Overall, the results suggest that bulk mineral waste materials have generally low levels of metal and metalloid enrichment, which is consistent with Permian-age coal measures throughout Qld.

Figure 15. Frequency distribution of geochemical abundance indices (GAI) of selected elements in spoil, coal, tailings and rejects)



5.4 Initial Solubility in Deionised Water

Water extract test results are available for a wide range of samples, as outlined in Table 16. Therefore, a large dataset is available to assess the potential for leaching of salt and environmentally important elements from mineral wastes (spoil, tailings and rejects) and coal at BWM. Water extract tests provide a preliminary indication of the elements that may be readily mobilised from any given material type.

The samples underwent a 1:5 w:v (solid:water) deionised water bottle leach procedure on fine pulps. Note that the use of fine pulped materials in water extract tests will enable a high level of reaction and dissolution. The test-work has found that bulk spoil, generally, is pH-alkaline to highly alkaline, non-saline to slightly saline and has very low to low concentrations of soluble metals and metalloid concentrations – within the range typical for Tertiary and Permian overburden and interburden materials in Queensland. For most spoil samples, the soluble metals and metalloids are at concentrations below or marginally above the laboratory limit of reporting (LOR). Comparatively, tailings and rejects (fresh and aged) have a much wider range of solubility characteristics compared to spoil – as expected.

Table 16. Samples subjected to deionised water solubility tests

Material type	pH and EC	Soluble metals and metalloids
	Number of samples	
Spoil	4464, comprising: • 657 weathered non-carbonaceous • 9 weathered carbonaceous • 3515 fresh non-carbonaceous; and • 283 fresh carbonaceous	618, comprising: • 132 weathered non-carbonaceous • 3 weathered carbonaceous • 417 fresh non-carbonaceous; and • 66 fresh carbonaceous
Tailings	699, comprising: • 309 fresh tailings from the NCPP • 390 aged tailings from TSFs	73, comprising: • 39 fresh tailings from the NCPP • 34 aged tailings from TSFs
Rejects	398, comprising: • 48 fresh rejects from the NCPP • 350 aged rejects from TSFs and rejects dumps	54, comprising: • 15 fresh rejects from the NCPP • 39 aged rejects from TSFs and rejects dumps
Coal	381	72

Electrical conductivity (EC) and pH

EC and pH data is available for 5942 samples at 1:5 w:v on pulp (**Figure 16**).

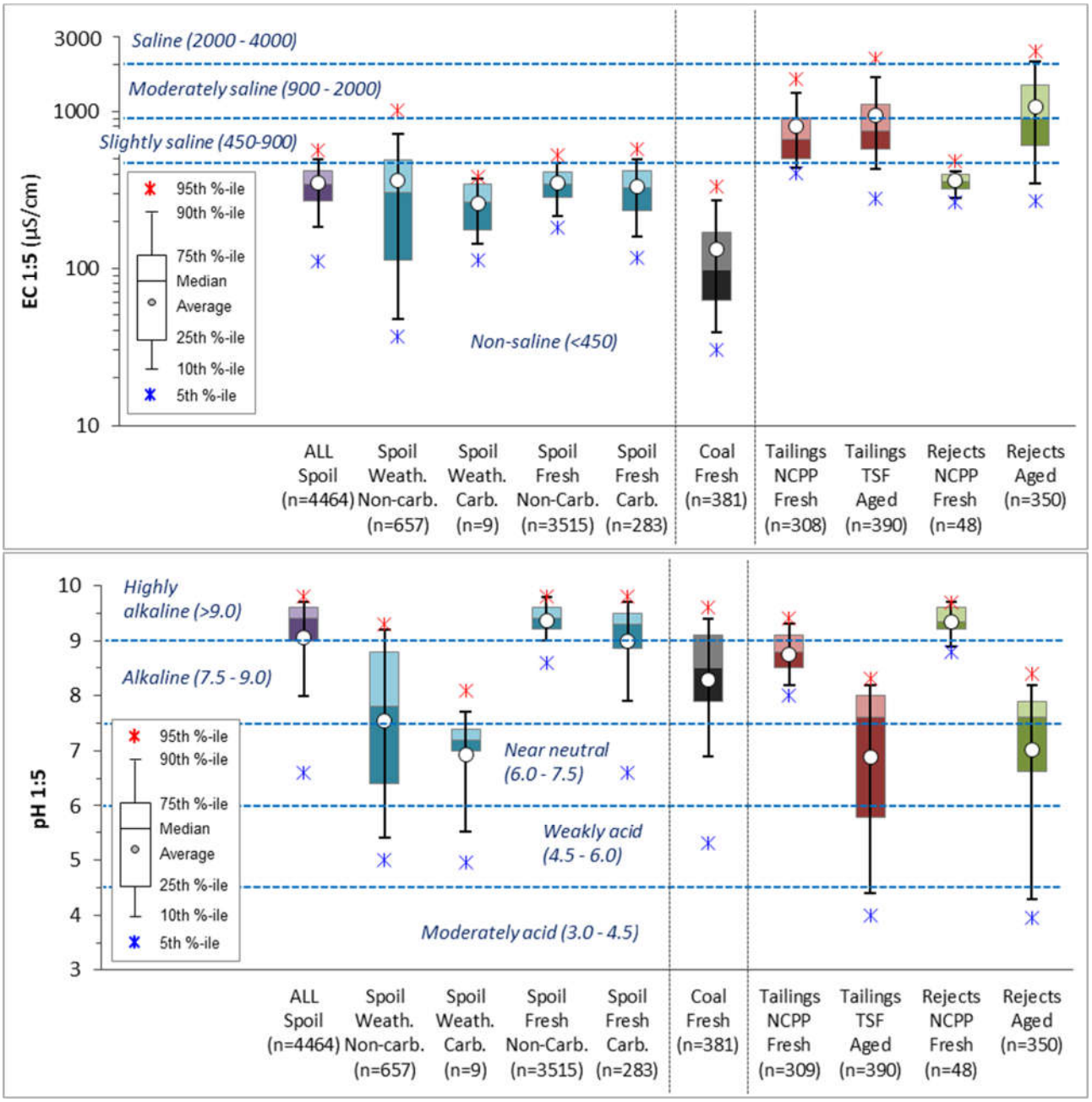
The $EC_{1:5}$ of 4464 spoil samples spanned a large range from less than 10 to 2790 μS/cm, with median, 75th and 95th percentile $EC_{1:5}$ values of 343, 418 and 571 μS/cm, respectively. As a bulk material, spoil is generally non-saline. These $EC_{1:5}$ results for spoil are common (if not typical) for Bowen Basin Permian and Tertiary material in the region.

There is generally little difference in $EC_{1:5}$ values between fresh and aged tailings, with fresh tailings (n=308) being slightly saline (median = 663 μS/cm) and aged tailings (n=390) being slightly to moderately saline (median = 748 μS/cm). Fresh rejects samples (n=48) were all generally non-saline whereas aged rejects (n=350) were generally slightly to moderately saline. Overall, bulk tailings and bulk rejects can be conservatively assumed to be slightly to moderately saline. Coal samples (n=381) are non-saline.

The $pH_{1:5}$ distribution by material type (**Figure 16**) shows bulk spoil, coal, fresh tailings and fresh rejects samples to be alkaline to highly alkaline. These pH results are common – if not typical – for Bowen Basin Permian and Tertiary material in the region. Some weathered spoil has naturally low $pH_{1:5}$ results (weakly acidic to near-neutral), which is typical for some weathered materials and is not due to AMD processes.

Approximately 27% of aged tailings and 23% of aged rejects samples were acidic to varying degrees – ranging from highly acidic through to weakly acidic. Of the 740 aged tailings and aged rejects samples (combined), 13% had $pH_{1:5}$ values between 4.5 and 6.0 (weakly acidic), 13% had $pH_{1:5}$ values between 3.0 and 4.5 (moderately acidic) and one aged tailings sample had $pH_{1:5}$ value less than pH 3.0 (pH 2.3 - highly acidic). In total, approximately 13% of all aged tailings and aged rejects samples had $pH_{1:5}$ values less than or equal to pH 4.5 and are classified as being moderately to highly acidic – evidence of sulfide oxidation and acid generation. Of these moderately to highly acidic aged tailings and aged rejects samples, almost all were from TSFs and reject areas located in the southern part of BWM, including Laleham TSF, Ramp 72 TSF, Bottom Dam TSF and from Red Dam area.

Figure 16. Electrical conductivity (EC) and pH distribution

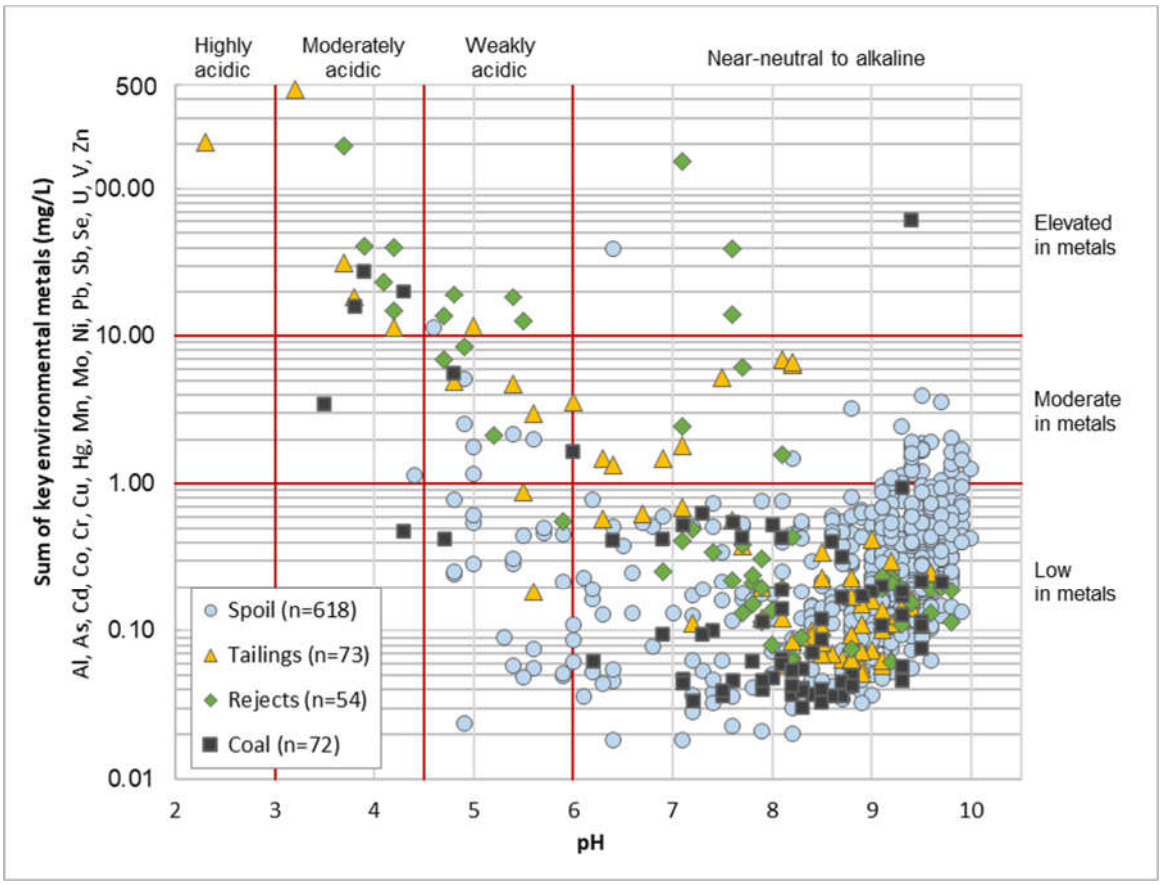


Soluble metals and metalloids

Deionised water extract (leaching) data for major ions and a broad suite of metals/metalloids are available for 817 samples (**Table 16**). All samples underwent a 1:5 w:v (solid:water) water extract procedure on pulps. All samples were analysed under ICP-MS method.

The sum of 16 environmentally important elements are plotted as a function of pH in **Figure 17**, in a modified version of what is referred to as a Ficklin plot (after Ficklin *et al.*, 1992). The 16 selected metals/metalloids comprise: aluminium (Al), antimony (Sb), As, cadmium (Cd), Co, Cr, Cu, lead (Pb), Hg, manganese (Mn), molybdenum (Mo), nickel (Ni), Se, U, vanadium (V) and zinc (Zn).

Figure 17. Sum of key environmental metals versus pH in deionised water extracts



The results, illustrated in **Figure 17**, show that:

- Eighty-six per cent (86%) of 817 samples – of all mineral waste types, including coal – have low soluble metals concentrations and have near-neutral to alkaline pH – indicating that under freshwater leaching conditions soluble metals concentrations are low for most mineral waste and coal materials.
- Over 89% of spoil samples have low soluble metals concentrations and have near-neutral to alkaline pH. Of the remaining 1% (approximately) of spoil samples:
  - Approximately 5% – mostly all fresh, non-carbonaceous – have near-neutral to alkaline pH but with moderate metals concentrations.
  - Approximately 4% – mostly all weathered, non-carbonaceous – are weakly acidic and with low metals concentrations.
  - Eight samples are weakly to moderately acidic and with moderate to elevated metals concentrations.
- Fifty-three (of 73) tailings samples (73%) have low soluble metals concentrations and have near-neutral to alkaline pH, including all 39 fresh NCPP tailings samples. The remaining 27% of tailings samples – all aged – have a wide range of soluble metals concentrations under a wide range of pH conditions. Generally, the NCPP TSF and Laleham TSF tailings samples had similar soluble metals concentrations, however the Laleham TSF samples had lower pH compared to the aged tailings samples from NCPP TSF.
- Thirty-five (of 54) rejects samples (65%) have low soluble metals concentrations and have near-neutral to alkaline pH, including all 15 fresh NCPP rejects samples. The remaining 35% of rejects samples – all aged – have a wide range of soluble metals concentrations under a wide range of pH

conditions. Most of the aged rejects with lower pH and moderate to elevated soluble metals concentrations were from Ramp 72 (Kenmare pit rejects).

- Sixty-three (of 72) coal samples (88%) have low soluble metals concentrations and have near-neutral to alkaline pH. The remaining 12% of coal samples have a wide range of soluble metals concentrations under a wide range of pH conditions.

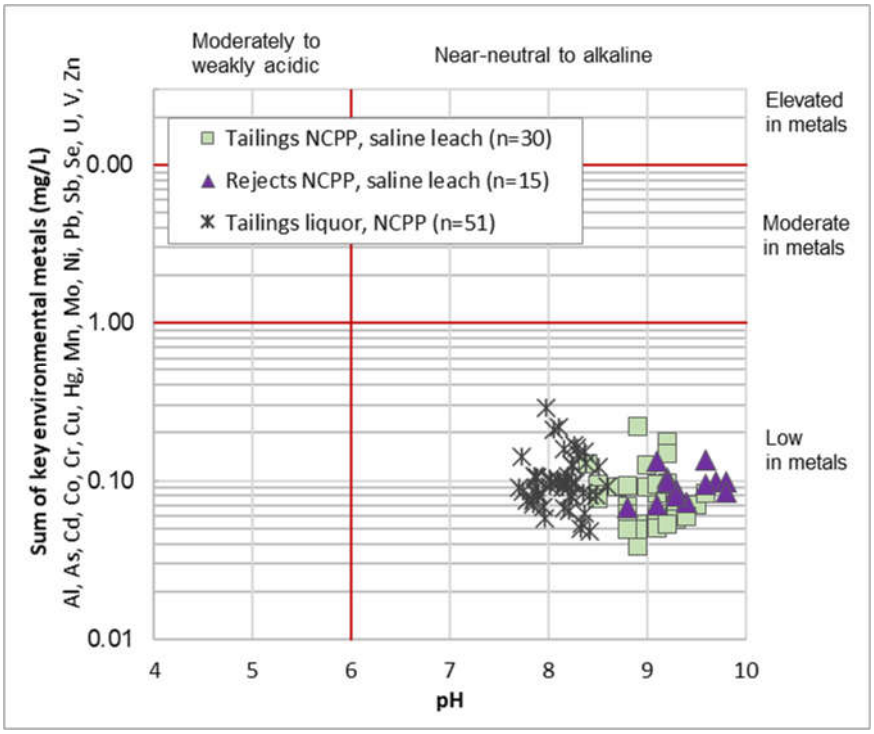
In pH-neutral to alkaline waters, many metals/metalloids cannot remain in solution and, thus, trace metal/metalloid concentrations are generally low. Comparatively, in acid(ic) waters, many metals/metalloids are highly soluble and remain in solution and, thus, trace metal/metalloid concentrations are generally high. Notable exceptions to these general rules include elements such as As, Mn, Sb and Se, which remain soluble through a wide pH range. Other trace metals that are somewhat soluble under pH-neutral to alkaline conditions include Cd, Cr, Mo and Zn. As such, under the pH-alkaline conditions of the leach, the mobility of these elements would not be inhibited.

5.5 'Saline' Water Solubility of Tailings and Rejects

Thirty (30) fresh tailings and 15 fresh rejects samples from NCPP underwent a 1:5 w:v (solid:water) mildly saline (brackish) water extract procedure on pulps using a 2 g/L sodium chloride (NaCl) leaching solution. This leach was undertaken to determine the solubility of metals and metalloids under 'brackish' conditions – which better simulate the normal (brackish) water quality of the NCPP process water. Note that the salinity of NCPP process water varies from fresh to brackish on a day-to-day basis depending upon the source of the water from within the mine water management system.

The sum of the concentration of 16 environmentally important elements are plotted as a function of pH from the saline leach solution for tailings and rejects in Figure 18 (along with the data for tailings liquor – see Section 5.6 below). The 16 selected metals/metalloids are the same elements as per the 1:5 deionised water leach. The results have shown that the solubility of tailings and rejects is low under 'brackish' leaching conditions.

Figure 18. Sum of key environmental metals versus pH in saline water extracts and tailings liquor



5.6 Characteristics of Tailings Liquor (Water)

Water quality data for tailings liquor is available for 51 tailings slurry samples collected from the NCPP (at the thickener underflow). The sum of the concentration of 16 environmentally important elements are plotted as a function of pH from the tailings liquor solution in **Figure 18** (along with the data for the saline leach solutions – **Section 5.5**). The 16 selected metals/metalloids are the same elements as per the 1:5 deionised water leach, saline water leach and peroxide leach.

All tailings liquor samples have near neutral to alkaline pH and low soluble metals concentrations. The liquor is highly saline, with EC values ranging from 2210 to 5410 μS/cm (median = 4220 μS/cm) and a median total dissolved solids (TDS) of 2700 mg/L. The dominant cation is Na and the dominant anions are Cl and SO_4 (equally dominant).

By comparison, the 2 g/L NaCl saline leach solution was less saline, with a median TDS for tailings and rejects 'saline' leach samples of 2113 mg/L and 2293 mg/L, respectively. The dominant cations and anions in the saline leach were Na and Cl, respectively, as expected due to the NaCl used to create the saline solution.

5.7 Peroxide Leachate Solutions

Peroxide leachate (NAG leach) data is available for 102 samples comprising:

- 5 weathered non-carbonaceous spoil samples – one classified as PAF-LC, one classified as UC(PAF) and three classified as NAF or UC(NAF).
- 9 fresh non-carbonaceous spoil samples: eight samples classified as UC(PAF) and one sample classified as PAF.
- 6 fresh carbonaceous samples: four samples classified as UC(NAF), one sample classified as UC(PAF) and one sample classified as PAF-LC.
- 8 coal samples: two samples classified as PAF and the remaining six samples classified as PAF-LC;
- 48 tailings samples (28 fresh and 20 aged) of mixed classifications (NAF to PAF, including UC(NAF) and UC(PAF)). Aged samples are from NCPP TSF and Laleham TSF;
- 26 aged rejects samples (6 samples from Ramp 36 rejects dump, 19 samples from Ramp 72 TSF and 1 sample from Laleham TSF) – mostly all 'PAF' classes, except for four samples classified as NAF and two samples classified as UC(NAF).

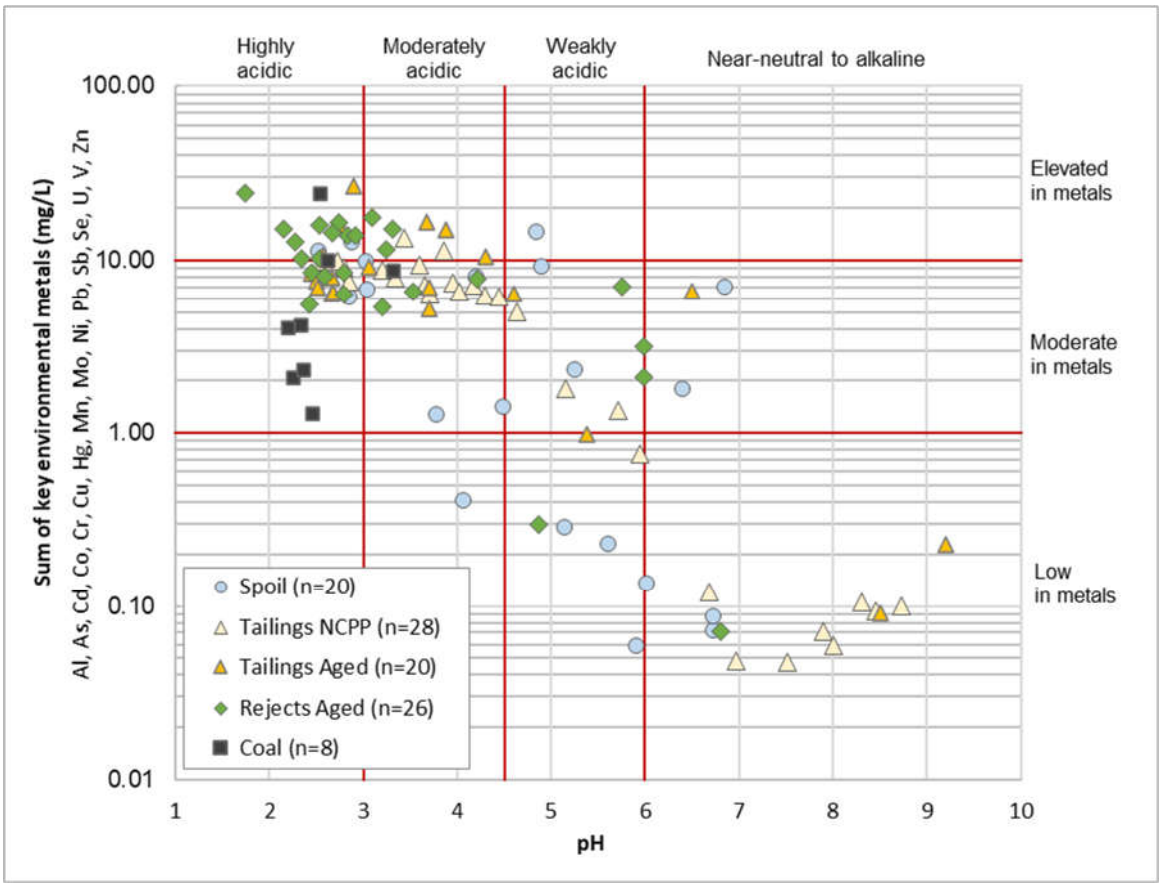
Peroxide leachate is the solution remaining from a single addition (standard) NAG test after the sample has been oxidised with peroxide to encourage oxidation and neutralising reactions, if ANC is available. The test encourages complete and rapid oxidation, with the resulting leach representing and assumed 'worse case' scenario in term of metal/metalloid mobility. The purpose of this test is to understand what metals/metalloids can be mobilised following full oxidation. The samples submitted for this test were selected to assess the hazard of similar waste type or to assist clarifying borderline geochemical properties.

It must be noted that samples with potentially high organic carbon concentrations, such as coal, some tailings and some reject samples, may be influenced by organic acids producing acidity and correspondingly elevated soluble metals concentrations unrelated to AMD. As such, the results for coaly and highly carbonaceous samples should be interpreted with this in mind.

The sum of the concentration of 16 environmentally important elements are plotted as a function of pH from the peroxide leachate solution in **Figure 19**. The 16 selected metals/metalloids are the same elements as per the 1:5 deionised water leach, saline leach and tailings liquor.

After undergoing a peroxide (NAG) leach a significant number of samples have acidic pH (ranging from weakly to highly acidic) and moderate to elevated soluble metals concentrations – primarily due to the low pH enhancing solubility.

Figure 19. Sum of key environmental metals versus pH in peroxide (NAG) leachate solution



Approximately 83% of samples (85 out of 102 samples) had pH less than 6.0 (i.e. acidic to some degree). Of the 17 samples plotting with near-neutral to alkaline pH (and mostly also with low soluble metals), 16 were classified as NAF or UC(NAF) and one sample classified as NAF-S – their classification being confirmed by the peroxide leach. Of the remaining (bulk of) samples producing some level of acidic pH, approximately 80% were classified as PAF, PAF-LC or UC(PAF) – their 'acidic' classification being confirmed by the peroxide leach.

All of the coal samples, almost all of the aged tailings and rejects samples and about three-quarters of the NCPP tailings samples were weakly to highly acidic and mostly had moderate to elevated metals concentrations. Extended NAG test results are available for three of the eight coal samples and 26 of the 48 tailings samples that underwent peroxide leaching. Of these, 13 tailings samples and all three coal samples had extended NAG test results that showed the presence of organic acids in these samples (i.e. producing extended NAGpH values greater than pH 4.5). Therefore, it's reasonable to conclude that many/most of these coaly and highly carbonaceous samples are likely producing elevated metals partially as a result of organic 'acidity', not necessarily from AMD.

The results suggest that under acid/acidic conditions, materials represented by these samples are capable of generating elevated metal and metalloid loads for several metals/metalloids, however the SO_4 (and salinity) loads are not expected to be high – due to the generally low total S concentrations (with exceptions for some tailings samples, and lesser so rejects). These data suggest that if PAF/PAF-LC material is allowed to oxidise without ANC available in the bulk media to buffer acidity, material similar to that tested might mobilise metals and metalloids at elevated concentrations, over time.

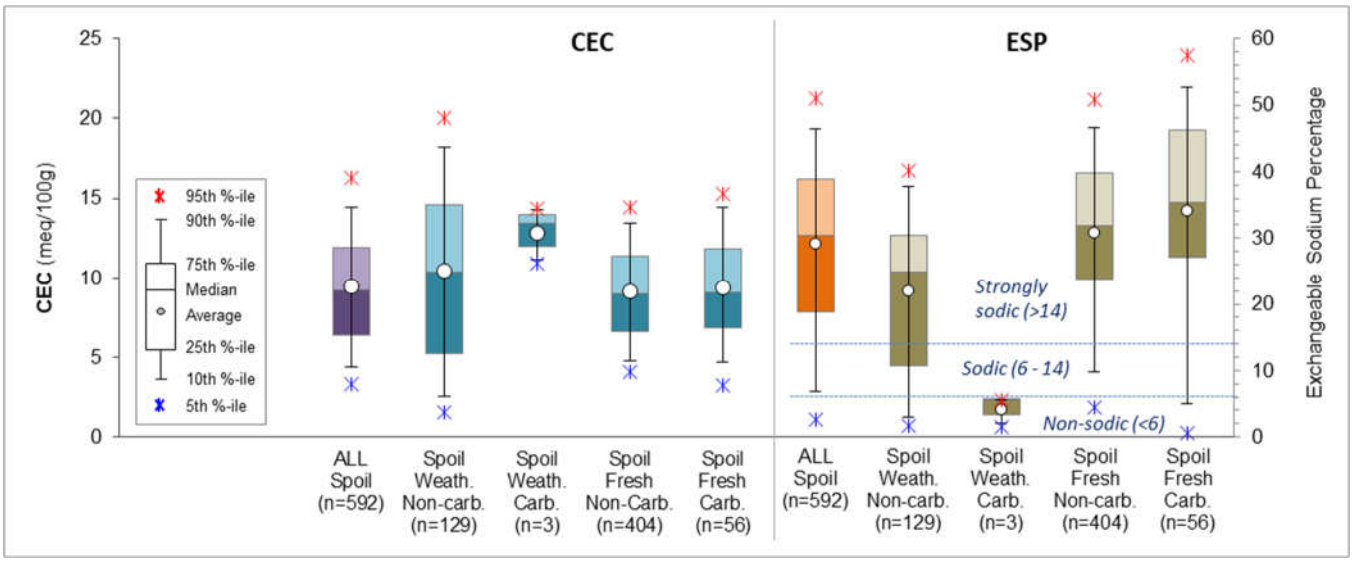
5.8 Cation Exchange Capacity, Sodicity and Dispersion Potential of Spoil

Exchangeable cation concentrations are used to evaluate the potential 'soil quality' of materials. Exchangeable cation data [as cation exchange capacity (CEC)] and exchangeable sodium percentage (ESP) is available for 592 spoil samples. The results are summarised in **Figure 20**.

The CEC spans a wide range from <1 to 31 milliequivalents per 100 grams (meq/100g), with low median and 75th percentile CEC values of 9.2 and 11 meq/100g, respectively. There was generally little difference between the CEC of the different spoil types (noting that data is available for only three weathered carbonaceous samples). Overall, spoil has low CEC values – meaning it has generally low capacity to hold and exchange cations and, as such, a low resistance to changes in soil chemistry.

The ESP results range from less than 1% to 100%, with a median ESP of 31%. Approximately 91% of spoil samples had ESP values greater than 6% and approximately 80% of spoil samples had ESP values greater than 14%. Therefore, based on the ESP values alone, essentially all spoil is regarded as being 'sodic' to 'strongly sodic' and, as such, a significant proportion of mine spoil at BWM can be expected to have potential for dispersion.

Figure 20. Cation exchange capacity (CEC) distribution and exchangeable sodium percentage (ESP) distribution of spoil



All 592 spoil samples tested for CEC and ESP also underwent Emerson aggregate class tests to determine whether these samples were dispersive. Emerson aggregate class tests are a direct measure of soil dispersion, whereas ESP values are used as an indirect measure of the *potential* for a sample to have structural stability problems and hence *may* be dispersive. The results show that about 58% of samples (346 out of 592 samples) displayed some degree of dispersion – either Class 1, 2, 3 or 5. The remaining 402 of samples (246 out of 592 samples) were non-dispersive, with Emerson Class numbers of 4, 6, 7

or 8. Refer to **Section 4.4** for class descriptions. Although not entirely consistent with the ESP results, the Emerson Class test results suggest a significant proportion of spoil would be dispersive.

Based on the CEC, ESP and Emerson aggregate class test results, a significant proportion of spoil at BWM is expected to be strongly sodic and dispersive.

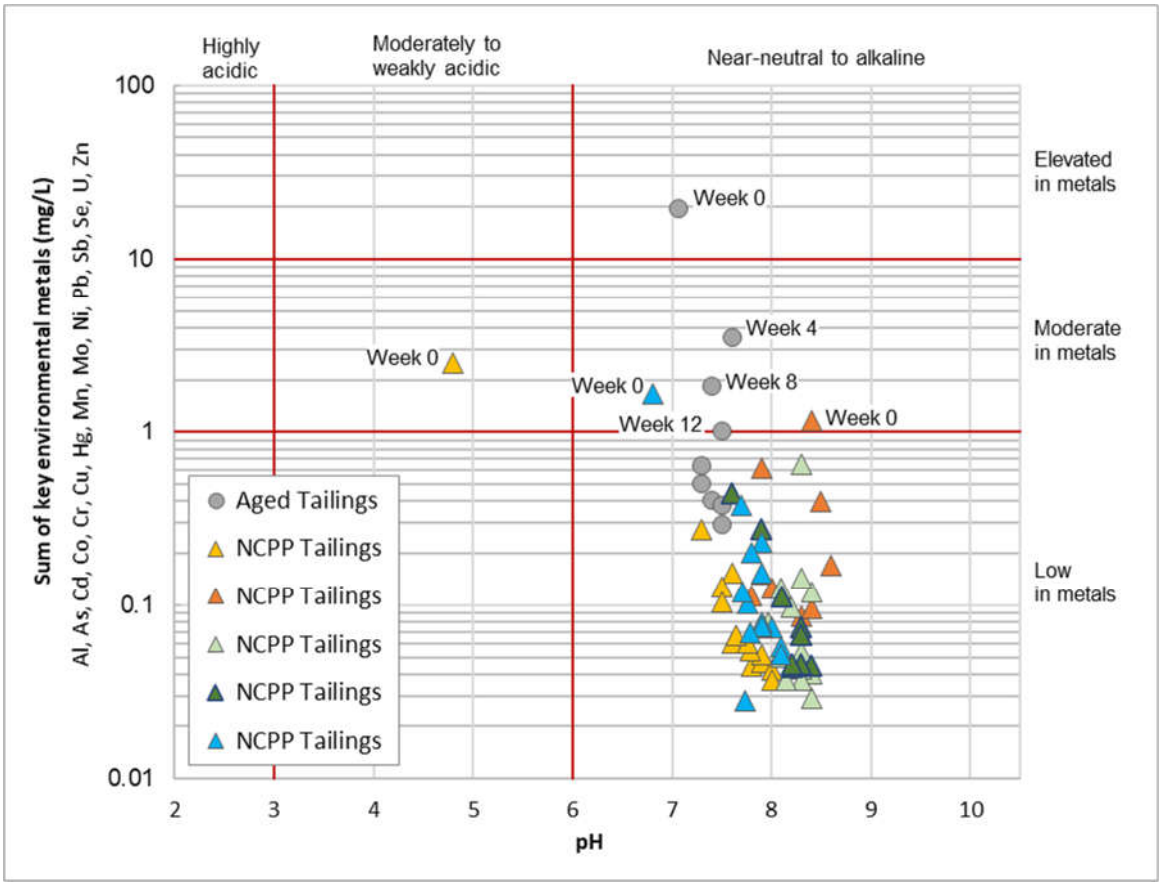
These exchangeable cation (and Emerson aggregate class) results are common for Bowen Basin Permian and Tertiary material in the region.

5.9 Kinetic Column Leaching

Free-draining kinetic column leaching test-work data is available for six samples, comprising five fresh (NCPP) tailings samples and one aged tailings sample from NCPP TSF. The samples were selected for column leaching test-work on the basis of static test results and had a range of AMD classifications from NAF to PAF (based on the static test-work). The column leaching method followed a modified AMIRA (2002) method (modifications to the 'standard' method were needed due to the very fine particle size of the samples) and samples were leached at four-weekly intervals with moistening and drying steps between the leaching events. The aged tailings sample and two of the fresh tailings samples were leached for 32 weeks (9 leach cycles including initial flush). The remaining three fresh tailings samples were leached for 52 weeks (14 leach cycles including initial flush).

The sum of the concentration of 16 environmentally important elements are plotted as a function of pH from the column leaching solutions in **Figure 21**. The 16 selected metals/metalloids are similar to the elements as per the 1:5 deionised water leach, saline leach and peroxide leach.

Figure 21. Sum of key environmental metals versus pH in kinetic column leachate solution



Most of the leachate from fresh tailings samples have low soluble metals concentration with the exception of three leaching events that had moderate soluble metals concentration and were associated with the initial flush (solute concentrations are typically higher in the initial flush as pre-existing salts are leached). All fresh tailings samples had near neutral to alkaline pH.

For aged tailings sample, the initial flush was elevated in metals, followed by moderate metals concentration during first three leach cycles (i.e. from week 0 to 12). Beyond the week 12 leach, the soluble metals concentration from aged tailings leachate was low. All aged tailings leachates were near-neutral to alkaline in pH.

The salinity of the samples (column leachate) for fresh tailings samples ranged from 563 to 9460 μS/cm with a moderately saline median value of 1230 μS/cm. The sulfate release rates for fresh tailings samples ranged from 22 mg/kg/week to 57 mg/kg/week.

For the aged tailings sample, the salinity ranged from 2110 to 6930 μS/cm with a saline median value of 2210 μS/cm. The aged tailings sample released sulfate at a rate of 147 mg/kg/week which was the highest among all samples leached.

The column leaching showed that none of the samples were acid forming (i.e. generating AD) throughout the leaching period. The aged tailings sample released higher levels of salts and elevated metals concentration compared to fresh samples.

5.10 OxCon Test-work

Data is available for OxCon test-work undertaken on five fresh (NCPP) tailings samples, one aged tailings sample from NCPP TSF and three carbonaceous spoil composite samples from drill-core. The tailings samples are the same samples that also underwent kinetic column leaching (Section 5.9). The test-work is summarised in Table 17 which also shows the preliminary AMD classification based on the static test-work alone (i.e. prior to the OxCon testing). The test-work found that:

- Two of the three spoil composite samples were confirmed to be NAF and are unlikely to generate AD or NMD (negligible risk) and are unlikely to be generating SD. One spoil composite spoil sample has a low potential to generate AD or NMD and is unlikely to be generating SD.
- Two of the five fresh (NCPP) tailing samples were confirmed to be NAF and are unlikely to generate AD or NMD (negligible risk) and with a low/negligible risk of generating SD. The remaining three fresh tailings samples were confirmed as PAF or PAF-LC and were found to pose a moderate to moderate-high risk of generating AD and low potential for SD.
- The aged tailings sample from NCPP TSF was confirmed as PAF and found to pose high potential for generating AD and low potential for SD.

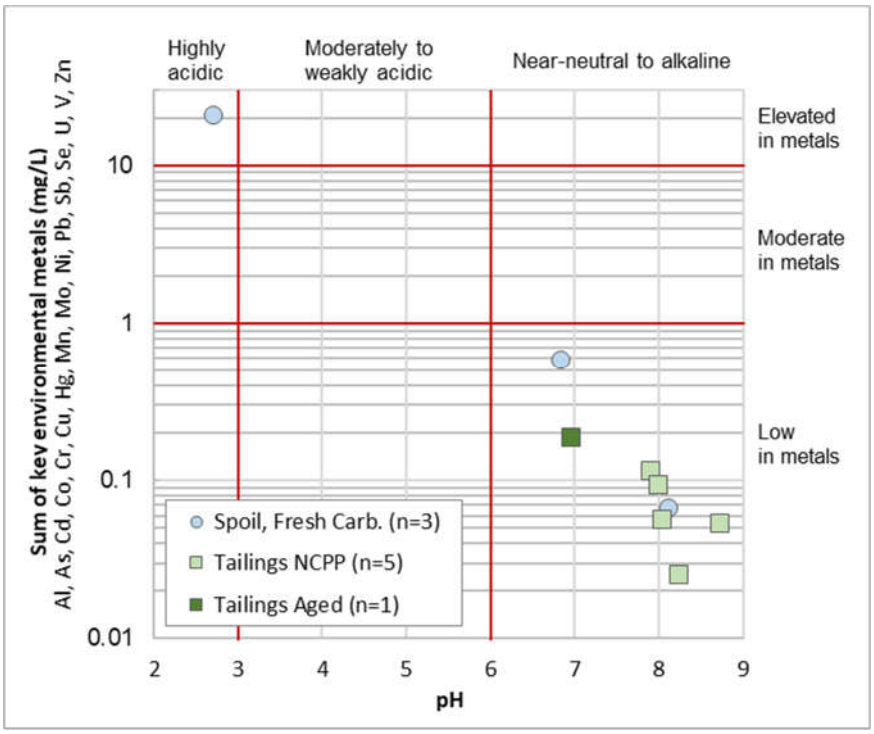
Table 17. Summary of OxCon results

Sample ID	Type / Source	Preliminary (pre-OxCon) AMD Classification	Avg. O2 consumption rate (mmol O2 /kg /day)	Max. acidity generation rate (kg H2SO4 /t /year)	Pyrite oxidation rate (wt.% pyrite /year)	Longevity of sulfide oxidation (years)	Lag time until ANC consumed (years)	Peak net acidity generation rate (kg H2SO4 /t /year)	AMD Classification based on OxCon Test
BWM_XTCM_Spoil	Spoil drillhole composites	UC(NAF) / PAF-LC	0.11	2.1	27	15	n/a	<0.1	NAF
BWM_EIS_13&31		PAF-LC	0.39	7.4	0.28	4	n/a	<0.1	NAF
BWM_EIS_31&33R		PAF-LC	0.60	12	0.34	4	~ 1.7	1.0	PAF-LC / UC(PAF)
BWM Tails 31-08-20	Tailings Fresh NCPP	PAF	0.48	9.3	55	10	~ 4	1.2	PAF-LC
BWM Tails 03-09-20		PAF	0.31	5.9	12	35	~ 9	2.1	PAF
BWM Tails 09-09-20		PAF-LC	0.51	9.7	80	5	< 1	8.3	PAF-LC
BWM Tails 04-09-20		NAF-S	0.60	11	53	10	n/a	<0.1	NAF
BWM Tails 18-10-20		NAF	0.43	8.2	0.57	2	n/a	<0.1	NAF
BWM-CPP-CPT51-INT06	Tailings aged NCPP TSF	PAF	0.63	12	11	38	~ 4	7.9	PAF

At the conclusion of the OxCon test, the solids underwent a bottle leaching procedure at a 1:2 solid:water ratio and the leachate was analysed to determine the pH, acidity/alkalinity and concentration of soluble metals/metalloids and salts. The sum of the concentration of 16 environmentally important elements are plotted as a function of pH from the post-OxCon leachate solution in **Figure 22**. The 16 selected metals/metalloids are the same elements as per the 1:5 deionised water leach, saline leach and peroxide leach.

As evident in **Figure 22**, all except one spoil sample produced low soluble metals/metalloid concentrations at near-neutral to alkaline pH. The PAF spoil sample produced highly acidic post-OxCon leachate with elevated soluble metals/metalloid concentrations.

Figure 22. Sum of key environmental metals versus pH in OxCon leachate solution



6 Summary of Geochemical Characteristics

The geochemical characteristics of mineral wastes (overburden/interburden [potential spoil], tailings and rejects) from BWM have been assessed – as have the characteristics of coal samples that may report as ROM coal or as waste to the spoil dumps. The assessment was undertaken to understand the environmental geochemical characteristics of these samples, as being representative of their respective mineral waste types.

Within the context of this PRCP, spoil comprises essentially all of (approximately 99% of) the mineral waste at BWM; and tailings and rejects comprise approximately 0.5% each. The proportions of spoil, tailings and rejects are expected to remain approximately the same for the expected life of the operation. Spoil is overwhelmingly comprised of non-carbonaceous material. Carbonaceous spoil (of which almost all is unweathered) comprises less than 8% of spoil.

6.1 AMD Potential of Mineral Wastes and Coal

AMD potential of spoil – non-carbonaceous

Non-carbonaceous spoil, which comprises about 92% of spoil, is expected to generate pH-neutral to highly alkaline contact water (run-off and seepage), which is typical for mine spoil in the Bowen Basin.

Based on the results from 4172 samples (657 weathered and 3515 fresh), non-carbonaceous spoil has a very low potential to generate AMD as either AD and/or NMD and/or SD, but for a small proportion that is assessed to have a higher potential to generate AMD (as AD, NMD and/or SD). However, in consideration of the mixing and dispersion of a small volume of waste at higher potential for AMD within the broader spoil material, the overall potential for non-carbonaceous spoil (and bulk spoil, generally) to generate AMD is assessed to be low.

The total S concentration of non-carbonaceous spoil is very low, with a 95th percentile total S concentration of 0.09%. As such, and combined with moderate to high ANC values (median 40 kg H_2SO_4/t), which is significantly higher than the MPA (median 0.6 kg H_2SO_4/t), approximately 97% of non-carbonaceous spoil samples tested were classified as NAF, with a further 1.3% (approximately) of samples classified as UC(NAF). Less than 1.5% of non-carbonaceous spoil samples were classified as PAF, PAF-LC, UC(PAF) or NAF-S. Only one sample was classified as NAF-S.

The test-work has demonstrated that the ANC for the non-carbonaceous spoil is generally expected to be about 36-73% available under field conditions (based on 25th and 75th percentile values), with iron-dolomite/dolomite and calcite being the main carbonate minerals contributing to the acid buffering potential of the non-carbonaceous spoil. Overall, non-carbonaceous spoil has excess acid neutralising capacity and is expected to be bulk acid consuming.

Total metal and metalloid concentrations from 548 non-carbonaceous spoil samples tested are very low compared to average element abundance in soil in the earth's crust. Fourteen samples (<3% of samples) were significantly enriched with regard to one or more of As, Ba, Co, Cr, Hg, S and/or Se. The enrichment in one or more of these elements in a small proportion of samples is not cause for concern. Of the samples displaying elemental enrichment, there was no correlation with AMD classifications of these samples. In summary, non-carbonaceous spoil has low enrichment in total metals and metalloids compared to un-mineralised rocks.

Soluble multi-element results (from 549 non-carbonaceous samples) indicate that leachate from this material is expected to contain low concentrations of soluble metals and metalloids under pH-neutral to

alkaline conditions. About 6% of samples produced moderate soluble metal concentrations under pH-neutral to alkaline leaching conditions; and about 4% of samples (almost all weathered) produced low soluble metal concentrations under weakly acidic leaching conditions. The remaining 1% (approximately) of samples produced moderate to elevated metals under weakly acidic conditions. Peroxide leaching undertaken on 14 non-carbonaceous spoil samples showed that PAF material has the potential to generate low pH leachate (AD) with moderate sulfate and soluble metal and metalloid concentrations.

AMD potential of spoil – carbonaceous

Carbonaceous spoil represents less than 8% of spoil material at BWM and – as a bulk material – is expected to generate pH-alkaline to highly alkaline contact water (run-off and seepage), similar to non-carbonaceous spoil.

Based on the results from 292 samples (nine weathered and 283 fresh), carbonaceous spoil has a generally low potential to generate AD and/or NMD and/or SD. Some carbonaceous spoil – mostly associated with coal seams – has a greater potential to generate low-level AD and/or NMD and/or SD.

The total S concentration of carbonaceous spoil is low, with 95th and 75th percentile total S concentrations of 0.59% and 0.25%, respectively. Approximately 85% of (248 out of 292) carbonaceous spoil samples were classified as NAF, with a further 4 samples (approximately 1.4% of samples) classified as UC(NAF). The remaining 14% (approximately) of samples were classified as PAF, PAF-LC, UC(PAF) or NAF-S and had a low-moderate 75th percentile total S value of 0.72%. Only two samples were classified as NAF-S. Most of the 'PAF' and NAF-S carbonaceous spoil samples were closely associated with coal seams.

The test-work undertaken has demonstrated that the ANC is generally expected to be about 17-41% available under field conditions (based on 25th and 75th percentile values), with iron-dolomite/dolomite and calcite being the main carbonate minerals contributing to the acid buffering potential of carbonaceous spoil. Overall, carbonaceous spoil has relatively modest acid neutralising capacity.

Total metal and metalloid concentrations from 69 carbonaceous spoil samples tested are very low compared to average element abundance in soil in the earth's crust, and very similar to the assay concentrations from non-carbonaceous spoil. Twelve samples were significantly enriched with regard to one or more of As, Cu, Hg, S and/or U. Of the samples displaying elemental enrichment, there was no correlation with AMD classifications of these samples. In summary, carbonaceous spoil has low enrichment in total metals and metalloids compared to un-mineralised rocks.

Soluble multi-element results (from 69 samples) indicate that, with few exceptions, leachate from carbonaceous spoil is expected to contain low concentrations of soluble metals and metalloids – similar to non-carbonaceous spoil samples. Peroxide leaching undertaken on six carbonaceous spoil samples (mixed 'NAF' and 'PAF') showed that the PAF samples have the potential to generate low pH leachate (AD) with moderate sulfate and soluble metal and metalloid concentrations. Most of the 'NAF' samples that underwent peroxide leaching produced leachate with near-neutral to alkaline pH and with low to moderate soluble metals concentrations.

AMD potential of tailings

The geochemical characteristics differed between fresh tailings from the NCPP versus aged tailings from TSFs for different parameters – particularly total S (and, by inference, MPA), ANC and pH. However, the overall geochemical (AMD) hazard posed by tailings from the two sources (fresh vs aged) was generally similar. As such, the discussion that follows only differentiates between the two tailings sources where the differences between the two sources was significant for some parameters and worthy of discussion. Else, the AMD potential of tailings is discussed as a bulk material.

Based on the results from 703 samples, approximately 55% of tailings has a moderate to high potential to generate AMD as either AD and/or NMD and/or SD, and the remaining 45% (approximately) has a relatively low potential to generate AMD as either AD and/or NMD and/or SD.

Fresh tailings from the NCPP are expected to generate pH-alkaline to highly alkaline contact water (run-off and seepage). Overall, aged tailings have lower pH compared to fresh tailings, however the pH in aged tailings ranged from moderately acidic to pH-alkaline. The difference in pH observed between fresh and aged tailings (and the differences within the aged tailings) may be due to a number of factors, however the most likely cause is oxidation processes consuming readily available neutralising minerals, leading to aged tailings generally having a low(er) acid neutralising potential.

The total S concentration of tailings is generally low-moderate, with median values of 0.76% and 0.52% for fresh and aged tailings, respectively. Overall, the total S concentration was higher in the fresh tailings compared to the aged tailings. The reasons for differences in total S between the fresh versus aged tailings is unclear and potential processes that could account for differences in total S concentration are:

- Sulfide oxidation and neutralisation reactions ongoing within the TSFs, which generate sparingly and / or readily soluble sulfate. Therefore, sulfur mass loss could have occurred from aged tailings due to leaching of sulfate minerals, such as jarosite, alunite and/or gypsum and/or readily soluble acid salts (e.g. iron sulfate 'salts' such as melanterite or copiapite).
- Change in geochemistry of ROM coal being processed. That is, ROM coal becoming more S-rich over time due to a change in the relative proportions of the various coal seams/plys being mined and processed.
- Addition of sulfate via salt precipitation within tailings during drying/evaporation of slurry water (liquor) [laboratory bias].

In the fresh tailings samples about 69% (median value) of the total S is present as sulfide (Scr). Comparatively, only 48% (median value) of the total S is present as Scr in the aged tailings samples. The difference in the proportion of total S as Scr between fresh versus aged tailings is typical and expected – supporting the suggestion that the aged tailings in the TSFs are being oxidised since deposition (sulfide oxidised to sulfate).

Just as there were notable differences between the total S concentrations in fresh versus aged tailings, so too with the ANC values of fresh versus aged tailings. Fresh tailings had generally moderate to high ANC values (median 32 kg H_2SO_4/t) compared to aged tailings, which had generally low to moderate ANC values (median 16 kg H_2SO_4/t). The reason behind the lower ANC observed in aged tailings (compared to fresh tailings) is not well understood. However, it is likely related to ANC being consumed via buffering of acidity generated by sulfide oxidation and/or sulfate leaching. Other processes that could account for a difference in ANC between fresh and aged tailings include inherent differences in the geochemical properties of the coal from earlier mining compared to recent mining, and/or – related to ROM coal differences; and it may also be partially due to differences in processing methods between the NCPP and the SCPP.

Based on the above generally low-moderate total S values (and, therefore, MPA values) combined with a wide range of ANC values resulted in approximately 55% of tailings samples being classified as PAF, PAF-LC, UC(PAF) or NAF-S – with the remaining 45% (approximately) classified as NAF or UC(NAF). Of the 'PAF' and NAF-S tailings samples, about 72% were classified as UC(PAF) or PAF-LC.

The test-work undertaken has demonstrated that the ANC in fresh tailings is expected to be about 47-67% available under field conditions, compared to about 12-63% available for aged tailings – based on

25th and 75th percentile values. Iron-dolomite/dolomite and calcite are expected to be the main carbonate minerals contributing to the acid buffering potential of tailings.

OxCon test-work undertaken on five fresh and one aged tailing samples found that two of the fresh tailings samples expected to be NAF or NAF-S were confirmed to be NAF and were unlikely to be generating AD or NMD. The remaining three fresh tailings samples, which were expected to be 'PAF' were confirmed to be PAF or PAF-LC and were found to pose a moderate to moderate-high risk of generating AD and low potential for SD. The aged tailings sample from NCPP TSF was confirmed as PAF and found to pose high potential for generating AD and low potential for SD.

With few exceptions, the total metal and metalloid concentrations from 56 tailings samples tested are generally low compared to average element abundance in soil in the earth's crust. About 26% of the fresh tailings samples and 29% of the aged tailings samples were significantly enriched with regard to S, which is consistent with the ABA data. Two aged tailings samples were significantly enriched with regard to silver (Ag). The GAI values also show that most of the tailings samples tested had minor enrichment (GAI = 1 or 2) with regard to S, which was consistent with the ABA data. There was no clear correlation found between AMD classifications of the tailings samples compared to elemental enrichment.

Solubility data indicate that under freshwater (deionised water) leaching conditions about 73% of tailings samples have low soluble metals concentrations and have near-neutral to alkaline pH, including all 39 fresh NCPP tailings samples. The remaining 27% of tailings samples – all aged – have a wide range of soluble metals concentrations under a wide range of pH conditions. Generally, the NCPP TSF and Laleham TSF tailings samples had similar soluble metals concentrations, however the Laleham TSF samples had lower pH compared to the aged tailings samples from NCPP TSF. Under saline leaching conditions fresh tailings produced low concentrations of soluble metals and metalloids.

Peroxide leaching undertaken on 48 tailings samples [about 60% classified as 'PAF' or NAF-S, and the remainder classified as NAF or UC(NAF)] showed that when exposed to highly oxidising conditions a significant proportion of tailings can produce weakly to highly acidic leachate with elevated soluble metals and metalloid concentrations. However, about one-third of tailings samples appeared to be influenced to some degree by the presence of organic acids, due to the samples' high organic carbon concentration. The presence of organic acids likely accounts, to some degree, for the acidity and 'elevated' soluble metals and metalloid concentrations evident in these tailings. Nevertheless, PAF tailings [including tailings classified as UC(PAF)] have typically produced moderate to elevated soluble metals and metalloid concentrations from the freshwater and peroxide leaching tests. These results indicate that PAF tailings have the potential to generate low pH leachate (AD), however the salinity (sulfate) loads are not expected to be high – due to generally low total S concentrations (with minor exceptions).

AMD potential of rejects

Based on the results of 398 samples, about 45% of the rejects have a moderate to high potential to generate AMD as either AD and/or NMD and/or SD, whereas the remaining 55% (approximately) of rejects has a relatively low to low-moderate potential to generate AMD as either AD and/or NMD and/or SD.

Fresh rejects from the NCPP are expected to generate highly pH-alkaline contact water (run-off and seepage). Aged rejects (from TSFs, Ramp 36 rejects dump and a small number of rejects in the Red Dam area) has lower pH compared to fresh rejects and is expected to generate weakly acidic to pH-alkaline contact water (run-off and seepage). The difference in pH observed between fresh and aged rejects – with the latter showing generally lower pH – may be due to a number of factors, however the most likely

cause is oxidation processes consuming readily available neutralising minerals, leading to aged rejects having a low(er) acid neutralising potential.

The total S concentration of fresh rejects was generally low (median value = 0.28%) compared to aged rejects, which had low to low-moderate total S values (median value = 0.61%). Aged rejects have come from multiple pit locations (different ROM coal) and processed from different CHPPs (NCPP and SCPP).

In the fresh rejects samples about 74% (median value) of the total S is present as sulfide (Scr), and in the aged rejects samples about 59% (median value) of the total S is present as Scr. The difference in the proportion of total S as Scr between fresh versus aged rejects is typical and expected – supporting the suggestion that the aged rejects in the TSFs and rejects dump(s) are being oxidised since deposition (sulfide oxidised to sulfate). Aged rejects may have been in place for nominally 5 to 30 years.

Just as there were notable differences between the total S concentrations in fresh versus aged rejects, so too with the ANC values of fresh versus aged rejects. Fresh (NCPP) rejects had generally moderate to very high ANC values (median 40 kg H_2SO_4/t) compared to aged rejects, which had generally low to high ANC values (median 18 kg H_2SO_4/t). The reason behind the lower ANC observed in aged rejects (compared to fresh rejects) is not well understood. However, it is likely related to ANC being consumed via buffering of acidity generated by sulfide oxidation and/or sulfate leaching. Other processes that could account for a difference in ANC between fresh and aged rejects include inherent differences in the geochemical properties of the coal from earlier mining compared to recent mining, and/or – related to ROM coal differences; and it may also be partially due to differences in processing methods between the NCPP and the SCPP.

Based on the above generally low to low-moderate total S values (and, therefore, MPA values) combined with a wide range of ANC values resulted in approximately 45% of rejects samples (all being aged rejects) being classified as PAF, PAF-LC, UC(PAF) or NAF-S – with the remaining 55% (approximately) classified as NAF or UC(NAF). All fresh rejects were classified as NAF.

The test-work undertaken has demonstrated that the ANC in fresh rejects is expected to be about 50-78% available under field conditions, compared to about 25-60% available for aged rejects. Iron-dolomite/dolomite and calcite are expected to be the main carbonate minerals contributing to the acid buffering potential of rejects.

No fresh rejects samples were significantly enriched with metals or metalloids. Four out of 17 aged rejects samples were significantly enriched with regard to S, which is consistent with ABA data for these samples. There was no correlation found between AMD classifications of the reject samples compared to elemental enrichment.

Solubility data indicate that under freshwater (deionised water) leaching conditions about 65% of rejects samples have low soluble metals concentrations and have near-neutral to alkaline pH, including all 15 fresh NCPP rejects samples. The remaining 35% of rejects samples – all aged – have a wide range of soluble metals concentrations under a wide range of pH conditions. Most of the aged rejects with lower pH and moderate to elevated soluble metals concentrations were from Ramp 72 (Kenmare pit rejects).

Peroxide leaching undertaken on 26 aged rejects samples of predominantly 'PAF' classifications showed that almost all rejects samples were weakly to highly acidic and had moderate to elevated metal and metalloid concentrations. The results suggest that under acid/acidic conditions, materials represented by these aged reject samples are capable of generating elevated metal and metalloid loads for several metals/metalloids, however the sulfate (and salinity) loads are not expected to be high – due to the generally low total S concentration (with some exceptions).

AMD potential of coal

Coal is not regarded as waste and ROM coal remains on-site for a relatively short period of time. However, some minor coal seams/plys will report directly as waste, and remnant coal (seams) will be exposed on the highwalls and end-walls of residual voids at closure.

Coal represents about 5% of all lithological material at BWM (i.e. about 2% to 7% of the highwall meterage, depending on the void; refer to **Section 7.1.4**, **Table 19**). Assuming the large majority of this will report as ROM coal, it is assumed that coal will represent a very small proportion of mineral waste (nominally 1-2%).

Based on the results of 381 samples, ROM coal is assessed as having a low-moderate to moderate potential to generate AMD as either AD, NMD and/or SD. A small proportion of coal would have a moderate to moderate-high potential to generate AMD. ROM coal, as a bulk material, is expected to generate pH-alkaline to highly alkaline contact water (run-off and seepage).

The total S concentration of coal is generally low (95th percentile total S concentration of 0.62%) and approximately 14% (median value) of the total S is present as sulfide (Scr), with the bulk of the total S likely present as organic S, which does not contribute to AMD. Coal samples have a wide range of ANC values; however, the median ANC is low (median = 11 kg H_2SO_4/t). As such, 64% of coal samples were classified as NAF or UC(NAF). One sample was classified as NAF-S. The remaining 35% (approximately) of samples were classified as PAF, PAF-LC or UC(PAF) and were from all seam groups. The AMD classification is based on total S, which for coal samples likely leads to highly conservative classification given that most sulfur in coal is organic S, not sulfidic S. These results suggest that coal stored on the ROM pad, coal located within pit walls and un-economic coal seam material reporting as spoil (mixed with non-coal spoil) would likely be bulk NAF.

Assay data for 72 coal samples show that the total metal and metalloid concentrations are generally low compared to average element abundance in soil in the earth's crust. Three coal samples were significantly enriched with regard to one or more of As and/or S.

Solubility data indicate that under freshwater (deionised water) leaching conditions about 88% of the 72 coal samples tested have low soluble metals concentrations and have near-neutral to alkaline pH. The remaining 12% of coal samples have a wide range of soluble metals concentrations under a wide range of pH conditions (moderately acidic to alkaline). These results indicate that some ROM coal is capable of generating AD and/or SD/NMD.

6.2 Salinity, Sodicity and Dispersion Potential of Mineral Wastes and Coal

Salinity, sodicity and dispersion potential of spoil – non-carbonaceous

Non-carbonaceous spoil has low median and 95th percentile $EC_{1:5}$ values of 344 and 569 μS/cm, respectively, and has very low total S concentrations. On this basis, contact water (run-off and seepage) is expected to be generally non-saline to slightly saline, as a result of dissolution of geogenic salts more so than from sulfide oxidation (sulfate salinity). Weathered non-carbonaceous spoil generally has similar $EC_{1:5}$ values compared to fresh non-carbonaceous spoil.

Non-carbonaceous spoil has low CEC values and generally high ESP values, resulting in approximately 91% of samples being classified as 'strongly sodic' or 'sodic' and, therefore, with potential for dispersion. Based on Emerson aggregate class testing to directly measure dispersion, about 59% of the non-carbonaceous spoil samples displayed some degree of dispersion. Although not entirely consistent with

the ESP results, the Emerson Class test results suggest a significant proportion of non-carbonaceous spoil would be dispersive.

Salinity, sodicity and dispersion potential of spoil – carbonaceous

Carbonaceous spoil has generally low median and 95th percentile $EC_{1:5}$ values of 328 and 574 μS/cm, respectively, and has low total S concentrations. On this basis, contact water (run-off and seepage) is expected to be similar to non-carbonaceous spoil. That is, generally non-saline to slightly saline, primarily as a result of dissolution of geogenic salts more so than from sulfide oxidation (sulfate salinity).

Carbonaceous spoil samples had comparable CEC and ESP values to non-carbonaceous spoil – with the main difference being the weathered carbonaceous samples having generally higher CEC and much lower ESP compared to the fresh carbonaceous samples. This resulted in most fresh carbonaceous samples being classified as 'strongly sodic' whereas the three weathered samples were all classified as 'non-sodic'. As such, and based solely on the moderate to high sodicity values, carbonaceous spoil is expected to be sodic (to some degree) with potential for dispersion. Based on Emerson aggregate class testing to directly measure dispersion, about half of the samples displayed some degree of dispersion, suggesting a significant proportion of carbonaceous spoil would be dispersive.

Salinity potential of tailings

Tailings samples (n=698) have $EC_{1:5}$ values ranging from 97 to 8900 μS/cm, with median, 75th and 95th percentile $EC_{1:5}$ values of 714, 1008 and 1976 μS/cm, respectively. There is generally little difference in $EC_{1:5}$ values between fresh and aged tailings, with both types being generally slightly to moderately saline. The generally low to low-moderate total S for aged tailings and low-moderate to moderate total S for fresh tailings conservatively suggests a low-moderate to moderate potential for SD (from sulfide oxidation).

Salinity potential of rejects

Rejects samples (n=398) have $EC_{1:5}$ values ranging from 123 to 2830 μS/cm, with median, 75th and 95th percentile $EC_{1:5}$ values of 797, 1398 and 2343 μS/cm, respectively. Fresh rejects samples were all generally non-saline whereas aged rejects were generally slightly to moderately saline. The generally low total S for fresh rejects and low to low-moderate total S for aged rejects conservatively suggests a low to low-moderate potential for SD (from sulfide oxidation).

Salinity potential of coal

Coal samples (n=381) have $EC_{1:5}$ values ranging from less than 10 to 722 μS/cm, with low median and 95th percentile $EC_{1:5}$ values of 99 and 332 μS/cm, respectively. Coal has generally low total S concentrations. On this basis, contact water (run-off and seepage) from coal, as a bulk material, is expected to be non-saline.

7 Risk Assessment

7.1 Geochemical source hazard assessment of material types

7.1.1 Spoil landforms

There are 14 spoil landforms at BWM that will remain at closure (listed below) – nine associated with existing (E) spoil dumps, four new landforms associated with future (F) mining areas and one landform comprising existing and future (EF) mining areas:

- Ramp 8 (F)
- Bonnie Doon (E)
- Mimosa-Besgrove (E)
- Deep Creek (E)
- Stewarton (E)
- Tannyfoil (E)
- Blackdown (E)
- South Ballamoo [Terang] (E)
- Kenmare (E)
- Ramp 74 [Laleham] (E)
- Togara-North Marshmead (EF)
- South Marshmead (F)
- Kennedy (F)
- Comet Downs East (F)

E = existing mining area; F = future mining area; EF = partial existing and future mining areas.

Each landform will have a similar construction, comprising mined overburden and interburden disposed behind the active mining face to form a low-wall spoil dump, which will be reshaped to form a final spoil landform.

Approximately 65% of all BWM rejects (to date) have been disposed into some of the spoil dumps during operations – primarily those spoil dumps located close to NCPP and SCPP. Of these, most (indicatively 90%) have been disposed into dedicated rejects disposal areas (e.g. Ramp 32 in-spoil rejects dump), with the remainder co-disposed (widely distributed) throughout general spoil at spoil dumps dump near NCPP. Where rejects are present in spoil landforms, they'll comprise between 0.2 and 1.9% (average 0.6%) of the spoil landform based on current rejects quantities, estimated future rejects quantities and assumed future rejects disposal practices. Rejects disposed into the southern end of Kenmare pit (Ramp 72 pit) are within the Kenmare spoil landform and comprise approximately 5% of all current/existing rejects [and about 0.5% of the Kenmare post-closure spoil landform].

Ramp 72 TSF is an in-ramp TSF located within the current Kenmare pit shell – and comprises approximately 1% of the Kenmare landform. Rejects located within the southern end of the current Kenmare pit also comprises approximately 0.5% of the Kenmare landform. Ramp 72 TSF and the rejects located in the southern end of Ramp 72 pit (Kenmare pit) are collectively comprised of about 70% tailings and 30% rejects (estimated proportions).

The conceptual layout of the spoil landforms (and residual voids) at closure is shown in **Figure 23** (northern part of the mine) and **Figure 24** (southern part of the mine); including the locations of existing TSFs and Ramp 36 rejects dump. At closure, the current (and future) spoil dumps will be reshaped and seeded (refer to the PRC Plan for spoil dump rehabilitation details).

Figure 23. Conceptual closure landform for the northern BWM area

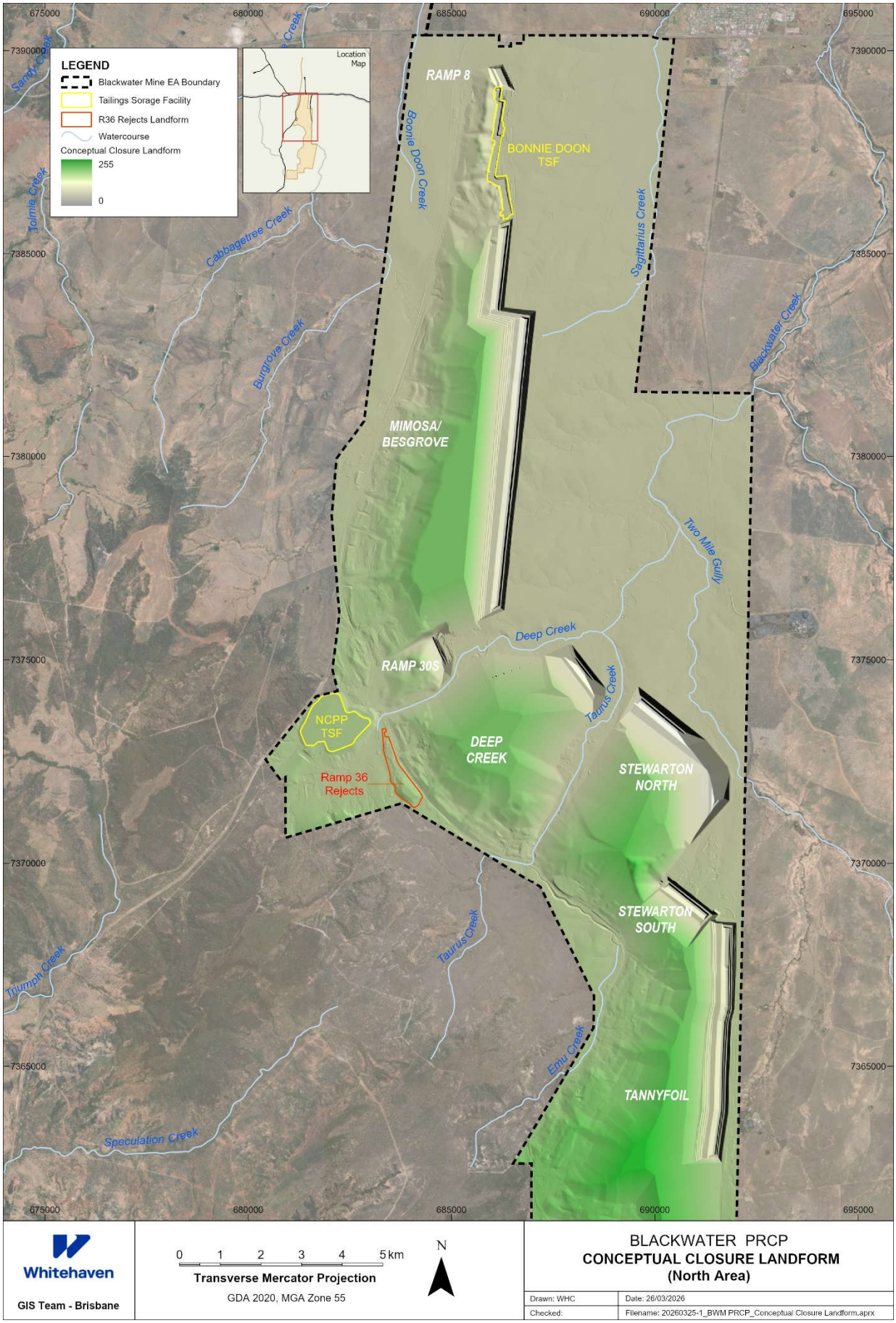
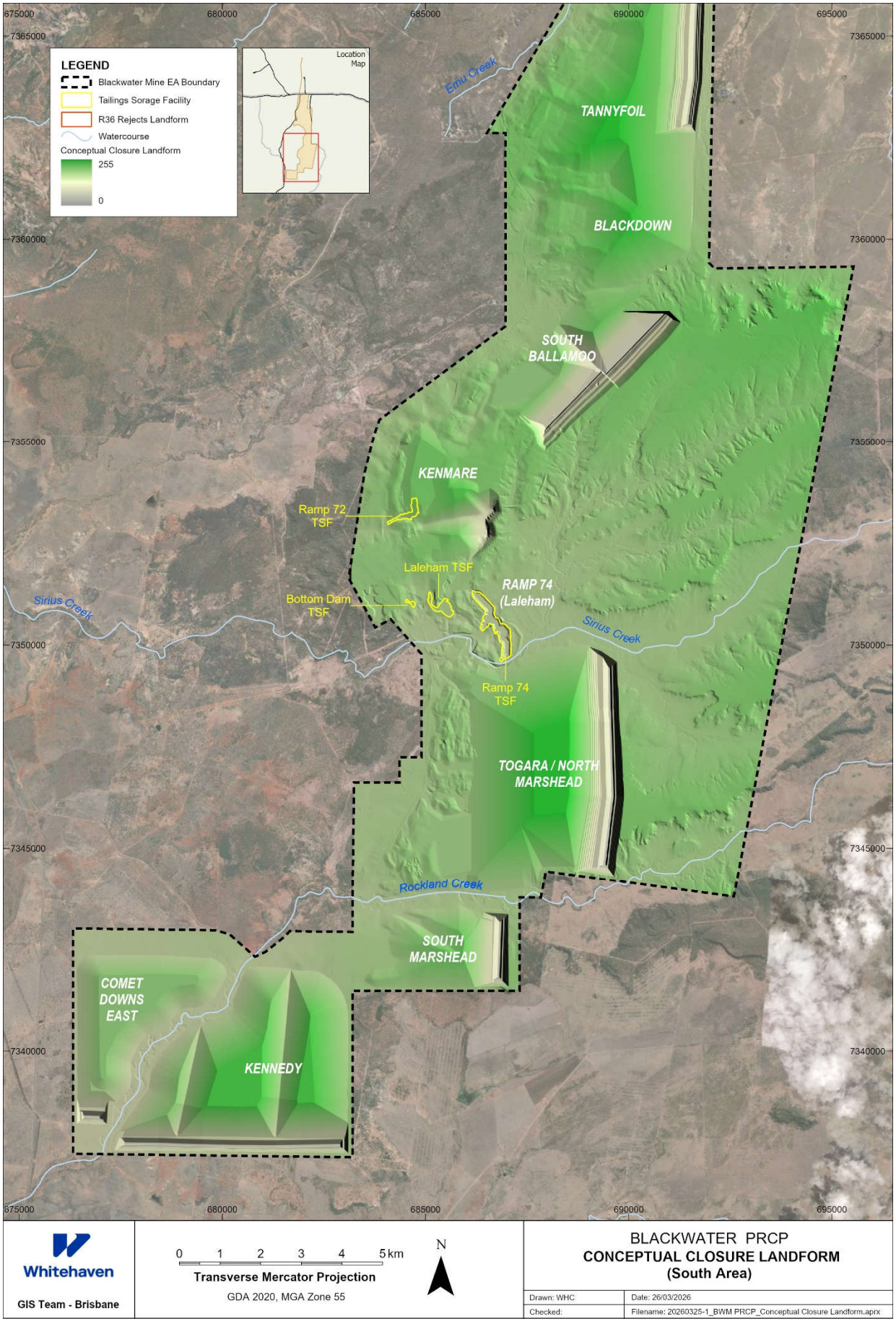


Figure 24. Conceptual closure landform for the southern BWM area



Approximately 30% of existing rejects are located at Ramp 36 rejects dump. Ramp 36 rejects dump is outside of a spoil landform and will remain as a stand-alone rejects landform at/post-closure.

TCP rejects (total volume less than 0.1 Mm^3) currently located near the TCP will be relocated into Mimosa-Besgrove spoil landform during rehabilitation of the TCP area.

The source materials within the spoil dumps predominantly comprise weathered and fresh spoil. The geochemical assessment has found that, from an environmental geochemical perspective, the geochemical differences between weathered and fresh materials are relatively minor. As such, the geochemical source hazard assessment has combined weathered and fresh non-carbonaceous spoil, and weathered and fresh carbonaceous spoil, as appropriate.

The source hazard assessment methodology outlined in **Section 4.4.6** (AMD hazard scoring) and **Section 4.4.7** (landform AMD likelihood scoring) has been applied to the spoil, rejects and tailings within each landform. Stratigraphic information from the BWM coal geology database was used to assess the proportion of carbonaceous lithologies relative to non-carbonaceous lithologies (and excluding coal) for each landform and void area – and from this, assign the same proportions to each spoil landform. The source materials, and their approximate proportions within each spoil landform, based on geological, mining and coal processing information, are summarised in **Table 18**.

Table 18. Source material proportions (%) within each spoil landform

Spoil landform	Spoil: Non-carbonaceous %	Spoil: Carbonaceous* %	Rejects %	Tailings %
Ramp 8**	96	4.0	none	none
Bonnie Doon	96	4.0	none	none
Mimosa-Besgrove	95	2.9	1.9	none
Deep Creek	96	3.0	0.8	none
Stewarton	96	4.0	<0.5	none
Tannyfoil	96	4.0	none	none
Blackdown	96	4.0	none	none
South Ballamoo [Terang]	95	4.0	0.8	none
Kenmare (includes Ramp 72 TSF and Kenmare pit rejects dump)	95	2.9	1.0	1.2
Ramp 74 [Laleham]***	99	1.0	none	none
Togara-North Marshmead	94	6.0	<0.5	none
South Marshmead	98	2.0	none	none
Kennedy	94	6.0	none	none
Comet Downs East	93	7.0	none	none

* Includes weathered coal and obvious waste coal lithologies (i.e. excludes potential ROM coal).

** Ramp 8 (future mining area) assessment was supplemented by data from Bonnie Doon.

*** Laleham TSF is located on the edge of (adjacent to) Ramp 74 spoil dump, but is not included as part of the Ramp 74 spoil landform. Laleham TSF is assessed as a 'stand-alone' TSF landform.

The assessment found that carbonaceous spoil (overburden/interburden) is estimated to comprise approximately 1% to 7% (average 4%) of spoil within each landform, with non-carbonaceous spoil estimated to comprise the remaining 96% (approximately, on average) of all spoil. Assuming some fresh coal material currently assigned as 'coal' is not mined as ROM coal but remains as waste coal, the proportion of coaly and carbonaceous overburden in each landform is likely to be slightly higher. However, coal comprises approximately 5% of the stratigraphy at BWM, therefore if a small amount of coal was to report as 'waste' the increase to the proportion of carbonaceous spoil would minimal.

The total rejects volume to date plus the estimated rejects volume for the remaining life of mine (i.e. total rejects producing for life of mine) ranges from approximately 0.2% to 1.9% of the total spoil landform volume at closure (as relevant to each specific landform). Overall, rejects currently comprise about 0.5% of all mineral waste at BWM and a similar proportion is expected for future rejects.

The source hazard assessment, which describes the AMD hazard of individual material domains within each landform (i.e. also takes into account material quantity), has found that non-carbonaceous spoil poses a **Low** AMD source hazard and carbonaceous spoil poses a **Low-Moderate** AMD source hazard. Where applicable, rejects generally pose a **Moderate** AMD source hazard within the spoil landforms – the AMD hazard score for rejects varied with location. Tailings are only located within Kenmare spoil landform and pose a **High** AMD source hazard. Rejects located within the southern end of Kenmare pit also pose a **High** AMD source hazard. The AMD hazard scoring tables for spoil landforms are provided in **Appendix B – Tables B1 to B14**.

Approximately 2% of spoil samples have been classified as PAF of some type (including NAF-S) (**Table 15**) – and most of this is from carbonaceous material, which comprises a minor proportion of spoil. Notably, most of the 'PAF'/NAF-S samples in overburden/interburden from drill-hole sampling were associated with seams as either roof, parting, floor or otherwise near-seam material (within about 1m above or below coal). As such, it is likely that a significant proportion of PAF spoil samples would be mined as part of ROM coal and would therefore end up as rejects instead of general spoil. Therefore, the AMD hazard score for spoil materials is considered to be conservative and consequently the final landform AMD hazard score also conservative.

On this basis, and taking into account material quantities (proportions) and expected proportion of PAF and NAF-S materials reporting to each individual landform, each of the 11 spoil landforms pose a **Low** AMD hazard, with AMD generation rated as **Highly Unlikely**. The 'Low' AMD hazard is largely a result of less than 1.5% of non-carbonaceous spoil samples being classified as PAF of some type (or NAF-S) – and non-carbonaceous spoil comprises the overwhelming majority of mineral waste within each spoil landform. Where rejects (and tailings) are present in specific landforms, their quantity (proportion of the landform) is very small and, as such, has a relatively minor affect on the overall landform AMD score.

Regarding Kenmare spoil landform specifically, the intrinsic AMD hazard of Ramp 72 TSF/tailings and rejects located at the southern end of the existing Kenmare pit – both of which will be contained (buried) within Kenmare spoil landform – is rated **Moderate-High to High** with the likelihood to generate AMD rated **Highly Likely** – due to AMD (as AD) having been observed from Ramp 72 TSF and from rejects within the existing Kenmare pit. Ramp 72 TSF and the rejects disposal area at the southern end of Kenmare pit are both within the Kenmare pit (void) shell. Rejects located near Ramp 70 within Kenmare spoil landform (at the northern end of the landform) pose a **Moderate** AMD hazard, with the likelihood to generate AMD rated **Probable/Likely**.

7.1.2 TSF landforms

NCPP TSF, Laleham TSF and Bottom Dam TSF/rejects will remain as stand-alone TSF landforms at closure and will not reside within a spoil landform. Ramp 72 TSF will be incorporated into Kenmare spoil landform. Refer to **Figure 1** and **Figure 23** for the location of NCPP TSF, and **Figure 2** and **Figure 24** for the location of Laleham TSF, Ramp 72 TSF and Bottom Dam TSF.

NCPP TSF

NCPP TSF is a large 'turkey's nest' style TSF with confining embankments on all sides, a base footprint of approximately 200 ha and has a total volume of approximately 26 Mm^3. NCPP TSF operated from approximately 1970 to 2023.

The source materials within NCPP TSF includes tailings, which are estimated to comprise approximately 80% of the landform; and rejects, which are estimated to comprise about 19% of the landform and form the basis of most of the embankments. The TSF landform also includes a small proportion (approximately 1 %) of spoil/fill material, predominantly within embankments.

Investigative drilling coupled with near-surface sampling has demonstrated that some tailings in the field at NCPP TSF are generating AMD (as AD and SD). Oxidation fronts are present in the TSF as demonstrated by decreasing sulfide concentrations from surface down, consumption of ANC, presence of secondary minerals generated through sulfide oxidation, and acid contact pH water.

The source hazard assessment for the mineral wastes within NCPP TSF landform has utilised the same general methodology as applied to the spoil landforms and other TSF and reject landforms. The source hazard assessment has found the tailings within NCPP TSF landform poses a **High** AMD source hazard; and rejects poses a **Low-Moderate** AMD source hazard. Fill material poses a low AMD source hazard, based on the low AMD hazard of general spoil. On this basis, and taking into account material quantities (proportions):

- NCPP TSF landform (currently, without a rehabilitation cover) poses a **Moderate-High** AMD hazard, with AMD generation rated as **Highly Likely**, the highest landform AMD likelihood category under the applied scoring procedure – noting that AMD has already been observed at/from this TSF. The AMD hazard is considered to predominantly lie with the tailings, and lesser so the rejects.

The AMD hazard score for the tailings and rejects materials is considered to be conservative and the landform domain AMD hazard score for NCPP TSF is also considered to be conservative. The AMD hazard scoring table for NCPP TSF landform is provided in **Appendix B – Table B15**.

Laleham TSF

Laleham TSF is largely constructed over spoil/fill (and also backfills a small pit). The TSF partly fills the upper reaches of a southeasterly plunging gully. The TSF abuts natural ground on the north and northwest, and overlies spoil/fill on the south and southeast. The TSF has a total area of approximately 12 ha and a total volume of approximately 4 Mm^3. The TSF operated from the late-1970s to the late-1980s, primarily receiving tailings from Laleham underground operation. Between 1990 and 1994 a thin spoil/soil cap was placed over the TSF and seeded/revegetated. This TSF has undergone rehabilitation and revegetation since decommissioning, however additional rehabilitation is assumed to be required prior to closure.

The source materials within Laleham TSF includes tailings, which are estimated to comprise approximately 90% of the landform; and rejects, which are estimated to comprise about 4% of the

landform. The TSF embankments (main embankment and upper embankment) are predominantly constructed from spoil/fill material, which comprise about 6% of the TSF.

Investigative drilling has demonstrated that tailings in the field at Laleham TSF are generating AMD (as AD and SD). Oxidation fronts are present in the TSF as demonstrated by decreasing sulfide concentrations from surface down, consumption of ANC, presence of secondary minerals generated through sulfide oxidation, and acid contact pH water.

The source hazard assessment for the mineral wastes within Laleham TSF landform has utilised the same general methodology as applied to the spoil landforms and other TSF and reject landforms. The source hazard assessment has found the tailings within Laleham TSF landform poses a **Moderate-High** AMD source hazard. Very little rejects data specific to Laleham TSF were available – therefore the AMD source hazard assessment for rejects at Laleham TSF utilised the aged rejects data from all rejects derived from SCPP, and found that rejects also pose a **Moderate** AMD source hazard. Fill material poses a low AMD source hazard, based on the low AMD hazard of general spoil. Evidence of AMD (as AD) is present from over 30% of the tailings samples collected from within the TSF. On this basis, and taking into account material quantities (proportions):

- Laleham TSF landform (currently, without a final rehabilitation cover[4]) poses a **Moderate-High** AMD hazard, with AMD generation rated as **Probable/Likely**. The AMD hazard is considered to predominantly lie with the tailings, and lesser so the rejects.

The AMD hazard score for the tailings and rejects materials is considered to be conservative and the landform domain AMD hazard score for Laleham TSF is also considered to be conservative. The AMD hazard scoring table for Laleham TSF landform is provided in **Appendix B – Table B16**.

Bottom Dam TSF (and rejects)

Bottom Dam TSF is a small historic tailings dam south of ROM 3 near the SCPP in the southern area of BWM (**Figure 2**). Adjacent to the TSF, and in the general vicinity of the TSF, are rejects dumps. Rejects currently occupy an area north of the TSF, on top of ROM 3, and also loosely dumped over the eastern and southeastern walls (escarpment) of ROM 3. ROM 3 is an elevated natural ground area northwest of Bottom Dam TSF and situated approximately 37 m above (higher than) the TSF.

The TSF (specifically) occupies an area of approximately 1.6 ha (with an estimated total volume of approximately 0.2 Mm^3). The overall Bottom Dam TSF/rejects area is approximately 10 ha, with an overall tailings/rejects volume estimated at less than 1 Mm^3 (indicatively 0.6 to 0.8 Mm^3).

The source materials within Bottom Dam TSF includes tailings, which are estimated to comprise approximately 95% of the landform; and rejects, which are estimated to comprise about 4% of the landform. The TSF landform is also assumed to include a small proportion (approximately 1 %) of spoil/fill material.

Tailings and rejects in Bottom Dam TSF/rejects were generated from the SCPP and are reasonably assumed to have environmental geochemical characteristics comparable to tailings and rejects located within Ramp 72 TSF, Kenmare pit and Laleham TSF. Preliminary investigative drilling and limited

4 Laleham TSF currently has a spoil cover, however additional rehabilitation will be required to meet post-closure rehabilitation criteria. As such, the AMD hazard assessment of Laleham TSF takes into consideration the existing cover material, however considers the facility to be 'unrehabilitated'.

sampling has demonstrated that all tailings at Bottom Dam TSF are classified as 'PAF' of some type and most show evidence of generating AMD (as AD and SD).

The source hazard assessment for the mineral wastes within Bottom Dam TSF landform has utilised the same general methodology as applied to the spoil landforms and other TSF and reject landforms. The source hazard assessment has found the tailings within Bottom Dam TSF landform poses a **Moderate-High** AMD source hazard. No rejects data specific to Bottom Dam TSF were available – therefore the AMD source hazard assessment for rejects at Bottom Dam TSF utilised the aged rejects data from all rejects derived from SCPP, and found that rejects pose a **Moderate** AMD source hazard. Fill material poses a low AMD source hazard, based on the low AMD hazard of general spoil. On this basis, and taking into account material quantities (proportions):

- Bottom Dam TSF landform (currently, without a rehabilitation cover) poses a **Moderate-High** AMD hazard, with AMD generation rated as **Probable/Likely**. The AMD hazard is considered to predominantly lie with the tailings, and lesser so the rejects.

The AMD hazard score for the tailings and rejects materials in Bottom Dam area is considered to be conservative and the landform domain AMD hazard score for Bottom Dam area (TSF and rejects combined) is also considered to be conservative. The AMD hazard scoring table for Bottom Dam TSF landform is provided in **Appendix B – Table B17**.

7.1.3 Rejects landforms

Ramp 36 rejects dump will remain as a 'stand-alone' rejects landform at closure. The dump is located approximately one km south of the NCPP and about 350 m southeast of NCPP TSF (**Figure 1** and **Figure 23**). The dump occupies an area of approximately 60 ha with a total estimated volume of approximately 10 Mm^3. The dump operated from approximately 1967 (start of mining at BWM) intermittently through until 2007. During this time, rejects have been taken (quarried) from the dump for use elsewhere on site – primarily for construction of the NCPP TSF embankments.

Ramp 36 rejects dump essentially comprises only rejects (approximately 98% by volume). A small amount of 'fill' (assume spoil) is also present and has been conservatively estimated (based on investigative drilling) to comprise about 2% of the landform.

The source hazard assessment for the mineral wastes within the rejects dump has utilised the same general methodology as applied to the spoil and TSF landforms. The source hazard assessment has found the rejects within the dump poses a **Moderate-High** AMD source hazard. Fill material has been assessed as posing a low AMD source hazard, based on the low AMD hazard of general spoil. Taking into account material quantities (proportions):

- Ramp 36 rejects dump (currently, without a rehabilitation cover) poses a **Moderate-High** AMD hazard, with AMD generation rated as **Probable/Likely**. The AMD hazard lies with the rejects, which comprise essentially all of the dump.

The AMD hazard score for the rejects materials is considered to be conservative and the landform domain AMD hazard score for the rejects dump is also considered to be conservative. The AMD hazard scoring table for Ramp 36 rejects dump is provided in **Appendix B – Table B18**.

7.1.4 Residual voids – exposed walls and floor

There are 15 existing and/or future pit areas at BWM that will remain at closure as residual voids. Some existing pits will merge with existing neighbouring pits to form larger consolidated pits/voids; some

existing pits will merge with future pits to also form larger consolidated pits/voids; and Blackdown pit (located between Tannyfoil and South Ballamoo pits/voids) will be backfilled. The voids don't have 'flat lying' floors and therefore the depth of each void varies along its length. The 15 residual voids remaining at closure are:

- Ramp 8 void approximately 0.6 km long and 60-85 m deep (at pit closure);
- Bonnie Doon void approximately 2.9 km long and 15-30 m deep (depth to tailings surface / spoil cap at pit closure). At closure, tailings thickness is expected to range from about 22 m thick at the southern end of the void to about 35 m thick at the northern end of the void;
- Mimosa-Besgrove void approximately 9.8 km long and 110-190 m deep (at pit closure);
- Ramp 30S void approximately 1.3 km long and 70 m deep (at pit closure);
- Deep Creek void approximately 1.7 km long and 150 m deep (at pit closure);
- Stewarton North void approximately 3.8 km long and 200-210 m deep (at pit closure);
- Stewarton South void approximately 1.5 km long and 130 m deep (at pit closure);
- Tannyfoil void approximately 5.9 km long and 100-130 m deep (at pit closure);
- South Ballamoo void approximately 4.5 km long and 200-270 m deep (at pit closure);
- Kenmare void approximately 1.6 km long and 120-150 m deep (at pit closure);
- Ramp 74 void approximately 1.8 km long and 25-30 m deep (depth to tailings surface / spoil cap at pit closure). Tailings thickness is about 25 m thick;
- Togara-North Marshmead void approximately 5.3 km long and 165-240 m deep (at closure);
- South Marshmead void approximately 1.7 km long and 160-205 m deep (at closure);
- Kennedy void approximately 5.6 km long and 90-175 m deep (at closure); and
- Comet Downs East void approximately 0.6 km long and 135 m deep (at closure).

Excluding the Bonnie Doon and Ramp 74 residual voids that have tailings on the pit/void floor, the floor of all residual voids at closure will be the P & L Lower seam group, which is currently the floor of most/all existing pits.

Environmental geochemical data, coal quality data and drill-hole geological logs have been used to aid in the assessment of AMD risk associated with residual void walls and floors, as explained in **Sections 4.4.1 to 4.4.3**.

The source materials within the walls and floor of each residual void comprise weathered and fresh materials. Excluding coal, on average, approximately 40% of the overburden/interburden on each highwall / end-wall is weathered/oxidised and the remaining (approximately 60%) is fresh, with the proportion of weathered to fresh overburden/interburden varying throughout the site. In the northern half of the site the proportion of weathered to fresh overburden/interburden is about 25% weathered to 75% fresh, whereas in the southern half of the site the proportion of weathered to fresh overburden/interburden is about 49% weathered to 51% fresh. As mining progresses the pits become only marginally deeper due to the generally low-angle dip of the seams. Therefore, the proportion of fresh material to weathered material at closure will remain broadly similar to current proportions.

The statistical distribution of residual void highwall / end-wall materials and the proportion of exposed coal seam (groups) is summarised in **Table 19**. Also shown is the composition (proportion) of each seam group exposed on the walls in each void (based on drill-hole data).

Table 19. Estimated wall rock exposure as a function of material type for each residual void

Voids	Weath, non-carb. %	Weath, carb./coal %	Fresh, non-carb. %	Fresh, carb./coal %	Unknown OB/IB %	Coal, fresh %	Coal seam groups Proportion of each seam group
Bonnie Doon (and Ramp 8[1])	17	0.1	73	3.5	-	6.7	T seam: 0.8% MR seam: <0.1% P&L seam: 5.9%
Mimosa-Besgrove (and Ramp 30S[1])	20	0.6	70	1.2	2.4	5.4	T seam:0.8% MR seam: 0.1% P&L seam: 4.5%
Deep Creek	22	1.0	68	1.2	0.6	7.1	T seam: 1.1% MR seam: 1.5% P&L seam: 4.5%
Stewarton Nth, Stewarton Sth, Tannyfoil and Sth Ballamoo[2]	23	1.6	65	1.1	1.7	7.2	T seam: 1.1% MR seam: 2.4% P&L seam: 3.7%
Kenmare	25	<0.1	65	1.2	4.1	5.1	T seam: 2.1% P&L seam: 3.0
Ramp 74	11	<0.1	82	0.8	-	6.0	T seam: 2.8% P&L seam: 3.2%
Togara-North Marshmead	73	5.6	19	0.4	-	2.0	T seam: 0.3% P&L seam: 1.7%
South Marshmead	59	1.3	37	0.7	-	2.6	T seam: 0.2% P&L seam: 2.4%
Kennedy	76	2.0	13	<0.1	6.8	1.9	T seam: - P&L seam: 1.9%
Comet Downs East	33	0.6	54	3.0	6.3	3.3	T seam: 1.0% P&L seam: 2.3%

1 Unable to undertake a specific void assessment for Ramp 8 and Ramp 30S voids due to insufficient data. Assume Ramp 8 void will have similar wall rock and seam proportions to Bonnie Doon void; and Ramp 30S void will have similar wall rock and seam proportions to the southern end of Mimosa-Besgrove void.

2 The void assessments for Stewarton North, Stewarton South, Tannyfoil and South Ballamoo voids were undertaken collectively (due to data limitations) and the values shown are averages for the three voids. However, the variation between each void is minor.

The T and P & L seam groups are the dominant seam groups at BWM (and colloquially referred to as the 'tops' and 'bottoms', respectively) and are present in every pit/void, whereas the MR seam group is a relatively minor seam group (overall) and is only present in the northern pits/voids from Ramp 8 through to South Ballamoo pit. The relative proportions of the T, MR and P & L seam groups are shown in **Table 19**. Overall, remnant coal (seams) are expected to comprise between 2% and 7% (vertical meterage) of the highwalls and end-walls in the residual voids.

Note that the source hazard assessment methodology outlined in **Section 4.4** has been applied to the materials expected to be exposed on the void walls and floor at closure.

The void walls hazard assessment has found that approximately 3.5% to 6% of the void highwall / end-walls in all voids is estimated to be PAF, which includes material classified as UC(PAF), PAF-LC and NAF-S. As such, the assessment has found that the likelihood of AMD generation from the void walls is **Unlikely**, and any expression of AMD from the void walls is likely to be localised.

Excluding Bonnie Doon and Ramp 74 voids, which have tailings on their floor, the floor of all other residual voids will be the P & L (lower) seam. On the highly conservative (if not overly conservative) assumption that the floor of each of these non-tailings voids is all coal, the void floor AMD hazard assessment has found that approximately 3% of the floor of these voids where coal is exposed is estimated to be 'PAF', which includes material classified as PAF, UC(PAF), PAF-LC and NAF-S. As such, the conservative assessment has found that the likelihood of AMD generation from the floor of these voids where coal is exposed is **Unlikely**, until such time that the floor becomes submerged by groundwater (post-closure). In practice, mining takes all coal to the bottom of the seam, therefore very little coal would be expected to remain on the floor of these voids.

Bonnie Doon and Ramp 74 voids have tailings as the void floor and the source hazard assessment – based on the AMD hazard posed by tailings – has found that approximately 46% of the floor of Bonnie Doon void and 72% of the floor of Ramp 74 void is estimated to be 'PAF' [tailings], which includes tailings classified as PAF, PAF-LC, UC(PAF) and/or NAF-S. AMD generation from the floor of these TSF voids is **Probable/Likely**. The tailings within these voids will be capped/covered at end of mining and no tailings will be exposed post-closure. As such, the likelihood for AMD generation from the floor of these voids post-closure would be lower. Should these tailings floors become submerged by groundwater (post-closure), the likelihood for AMD generation from the tailings floor of these voids would be lower.

The AMD hazard scoring tables for the residual voids are provided in **Appendix B – Tables B19 to B29**.

7.2 Geochemical source-pathway-receptor assessment

7.2.1 Conceptual site model

A post-mining conceptual site model (CSM), which applies generically to the spoil landforms and their respective residual voids and the relationship these facilities have with surface water and groundwater in the district, has been produced by SLR Consulting Australia (SLR, 2026). The CSM for the northern part of the mine is provided in **Figure 25** and for the southern part of the mine in **Figure 26**.

The CSM assists with the source-pathway-receptor (SPR) assessment with regard to potential environmental geochemical impacts from mineral waste facilities. The CSM, which focuses on the relationship with surface water and groundwater (these being the most relevant pathways and receptors for AMD and salinity), is used to illustrate the relationship between potential sources of run-off and seepage (e.g. spoil, tailings, rejects), plausible receptors (e.g. creeks, groundwater) and the pathways between the two (e.g. seepage, drainage).

Figure 25. Conceptual site model post-mining for the northern BWM area
(SLR, 2026)

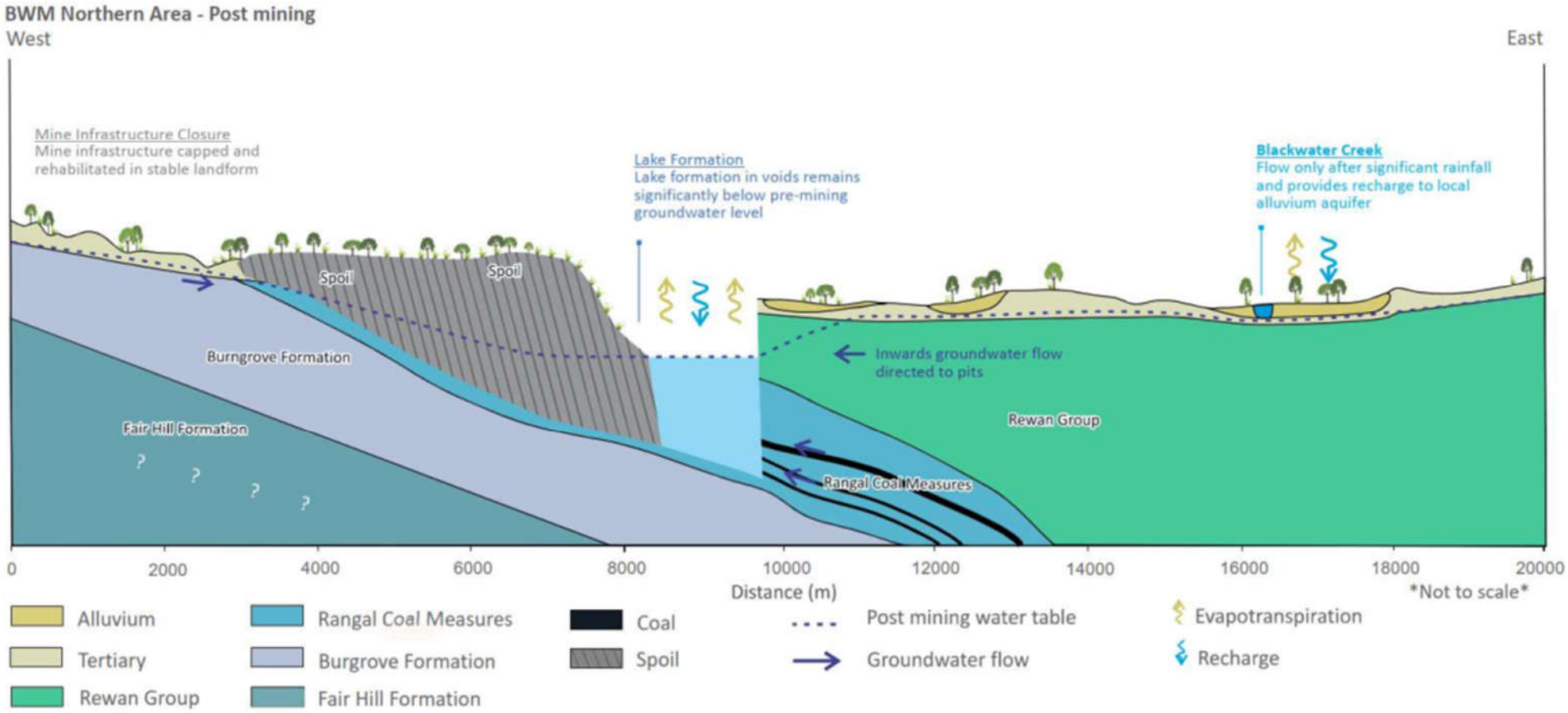
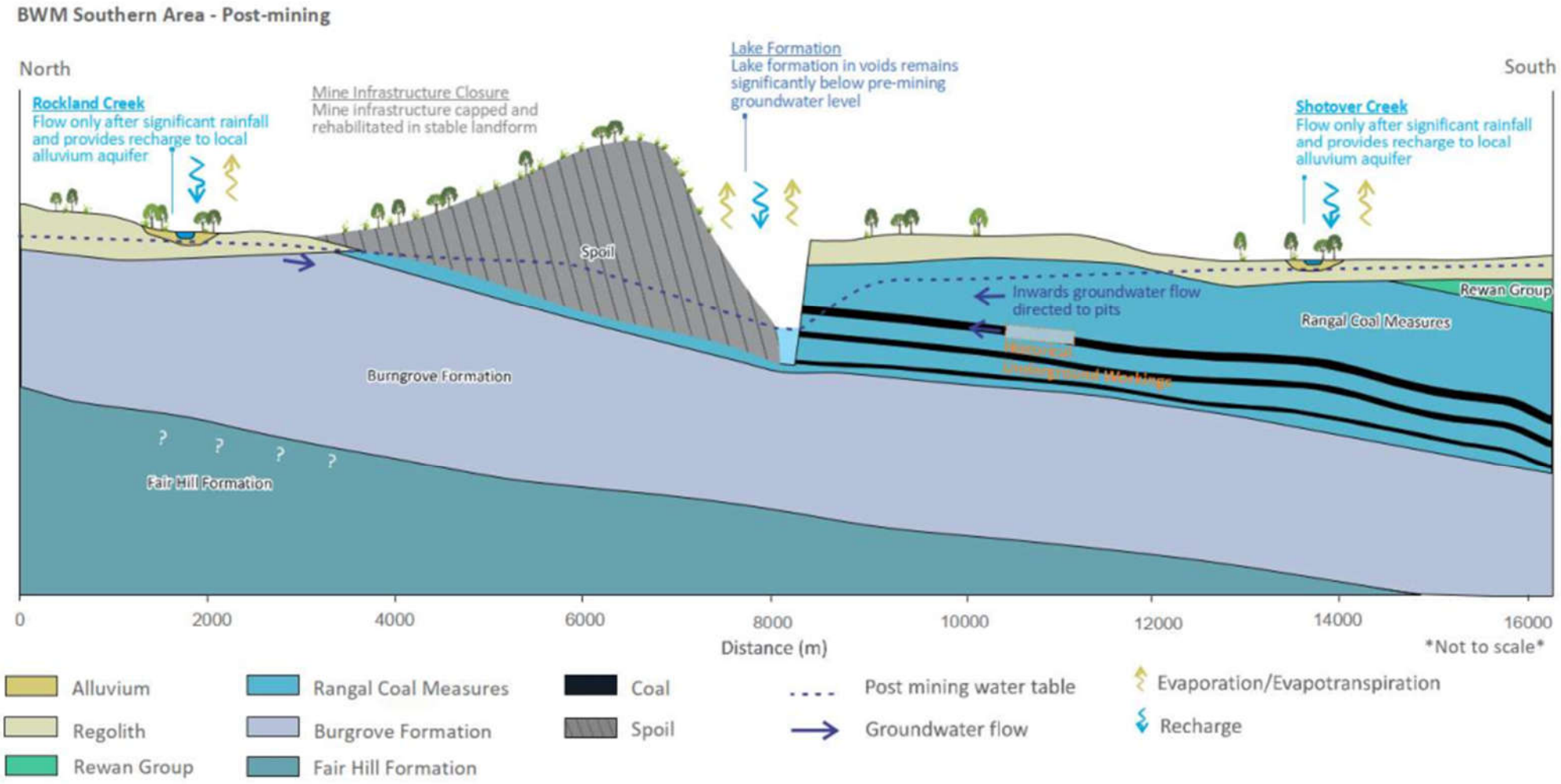


Figure 26. Conceptual site model post-mining for the southern BWM area
(SLR, 2026)



Prior to mining, groundwater flow in the northern half of BWM would have been generally towards the north and groundwater flow in the southern half of BWM would have been generally towards the southwest. Locally, these groundwater flow directions have been interrupted by mining, with current groundwater flow directions in the vicinity of the mine being towards the pits (i.e. the pits are currently groundwater 'sinks'). Permian groundwater flow at BWM largely follows the coal seams down-dip. Shallower groundwater that is likely associated with shallow permeable strata is likely to flow in a direction that broadly mimics surface topography.

Groundwater modelling undertaken by SLR (2026) shows the residual voids will ultimately be groundwater 'sinks' – that is, the residual voids will be receptors of run-off and seepage from the spoil landforms and run-off from void highwalls and end-walls, as illustrated in the CSM (**Figure 25** and **Figure 26**). The residual voids are classified as non-use management areas (NUMAs). The spoil landforms are located behind (generally west of) the residual voids and will drain into the voids. Seepage from the spoil landforms and the highwalls and end-walls of the residual voids reports to the residual void. As such, the floor of residual voids (including the floor of Bonnie Doon and Ramp 74 voids being tailings) are not likely AMD sources for groundwater receptors.

The hydrogeological assessment undertaken for the PRCP (SLR, 2026) indicates there may be shallow permeable strata present sporadically along (and/or near to) several creeks at BWM and – where present – shallow groundwater is expected to be below the base of all creeks in the area; suggesting that connectivity between shallow permeable strata and surface water features at BWM is unlikely. Furthermore, modelling (including particle tracking) undertaken by SLR for the PRCP found no evidence of post-closure connectivity between groundwater and surface water features. The model suggests that shallow groundwater (and by extension shallow seepage) migrating through the site will eventually report to the mine pits/voids. The general downward migration of shallow groundwater (and seepage) into deeper groundwater and towards the mine pits (residual voids) is logical, given the very large drawdown (sink) of the pits.

The assessment of shallow groundwater at BWM – particularly where shallow permeable strata may not be present in some areas or may be discontinuous – is limited by/to the distribution of the shallow bore network, which is sporadic. Therefore, despite the apparent low likelihood of substantial connection between shallow permeable strata and surface water features, the SPR assessment has adopted a highly conservative approach and assumed a plausible pathway *may exist* between shallow permeable strata and surface water features.

7.2.2 Conceptual facility models

A conceptual facility model (CFM) has been developed for each TSF and rejects landform to illustrate potential run-off and seepage pathways and surface water and groundwater receptors associated with these key mineral waste facilities post-closure.

- NCPP TSF – prior to rehabilitation – has a Moderate-High AMD source hazard with the likelihood of AMD generation from the landform rated as Highly Likely. CFM shown at **Figure 27**.
- Laleham TSF – prior to rehabilitation – has a Moderate-High AMD source hazard with the likelihood of AMD generation from the landform rated as Probably/Likely. CFM shown at **Figure 28**.
- Bottom Dam TSF and rejects area – prior to rehabilitation – has a Moderate-High AMD source hazard with the likelihood of AMD generation from the landform rated as Probable/Likely. CFM shown at **Figure 29**.

- Ramp 36 rejects dump – prior to rehabilitation – has a Moderate-High AMD source hazard with the likelihood of AMD generation from the landform rated as Probably/Likely. CFM shown at **Figure 30**.
- Ramp 72 TSF and Kenmare pit rejects dump will be buried within Kenmare spoil landform and will form tailings and rejects components of the spoil landform. The concentrated nature of Ramp 72 tailings and Kenmare pit rejects (which both have a High AMD source hazard) located at the base of the spoil landform warrants discussion with respect to SPR assessment. CFM shown at **Figure 31**.
- Deep Creek (Ramp 32) in-spoil rejects dump will be buried within the southern zone of Mimosa-Besgrove spoil landform. The concentrated nature of Deep Creek rejects (which has a Moderate AMD source hazard) located at the base of Ramp 32 and near the edge of the spoil landform close to Deep Creek warrants discussion with respect to SPR assessment. CFM shown at **Figure 32**.

Figure 27. Post-closure Source-Pathway-Receptor (SPR) conceptual facility model (CFM) for NCPP TSF landform

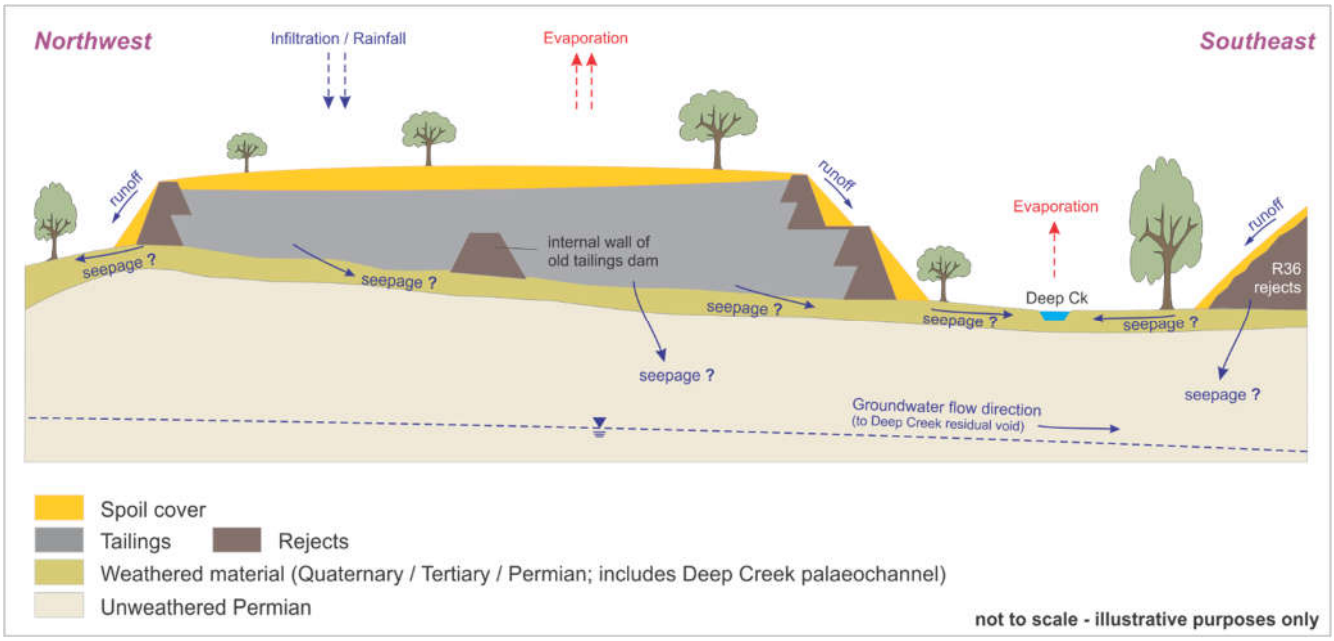


Figure 28. Post-closure Source-Pathway-Receptor (SPR) conceptual facility model (CFM) for Laleham TSF landform

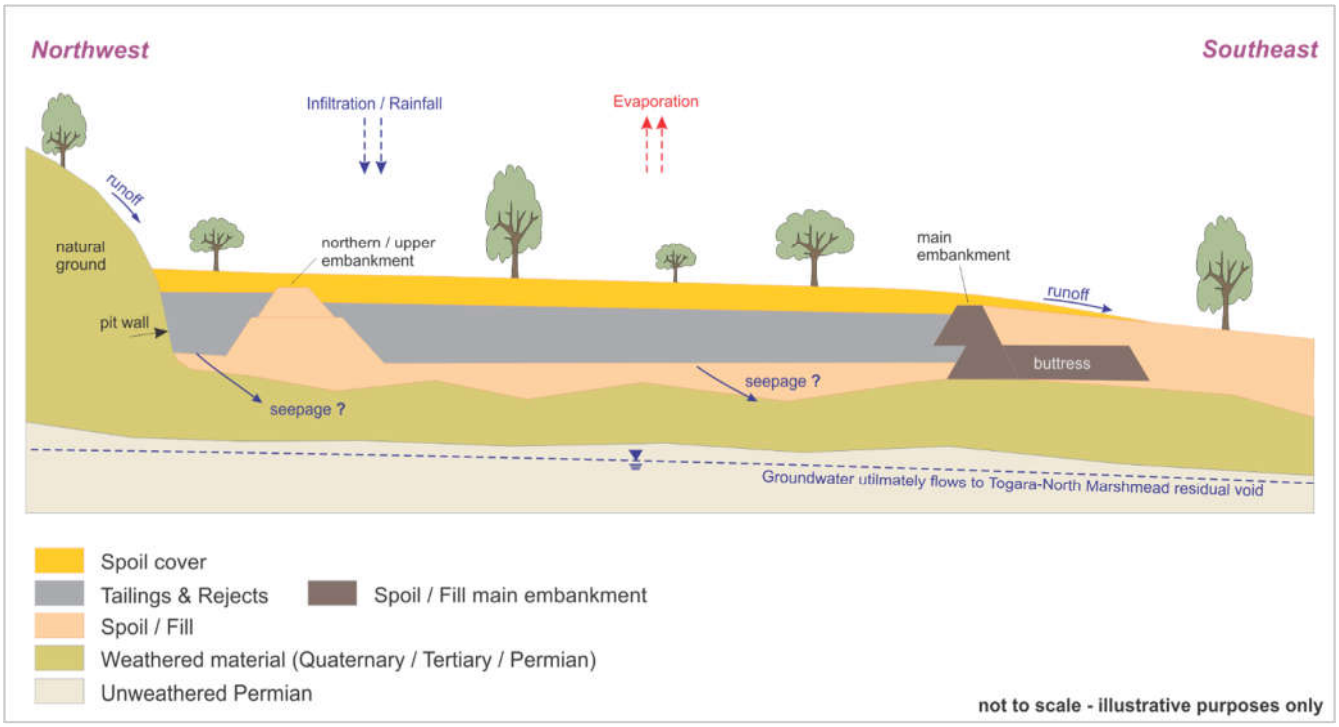


Figure 29. Post-closure Source-Pathway-Receptor (SPR) conceptual facility model (CFM) for Bottom Dam TSF and rejects landform

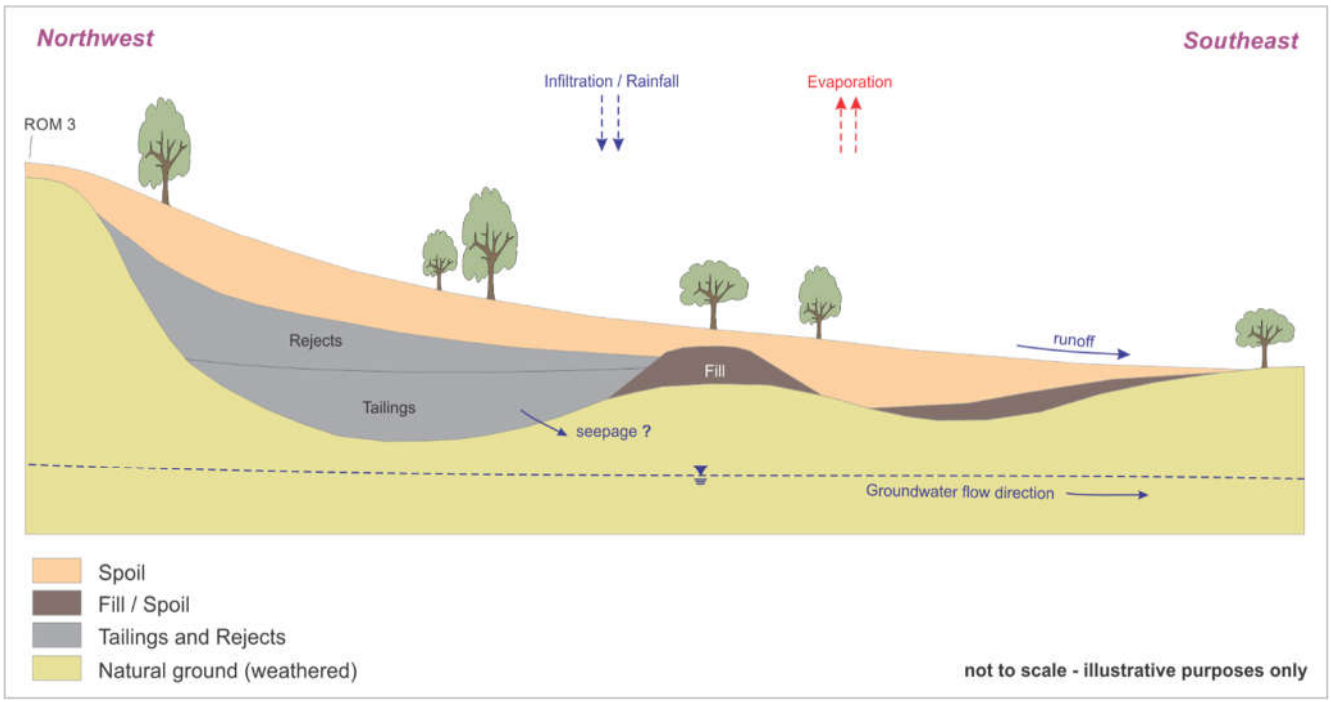


Figure 30. Post-closure Source-Pathway-Receptor (SPR) conceptual facility model (CFM) for Ramp 36 rejects landform

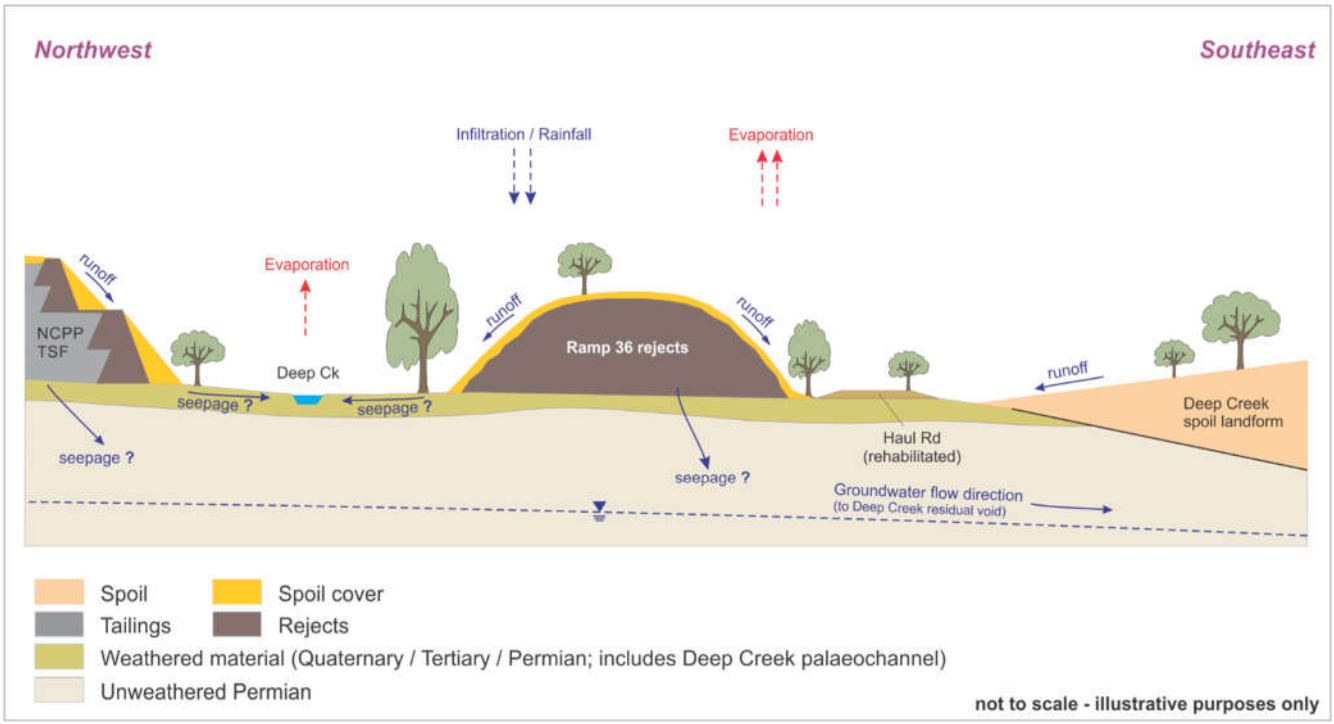


Figure 31. Post-closure Source-Pathway-Receptor (SPR) conceptual facility model (CFM) for Ramp 72 TSF buried within Kenmare spoil landform

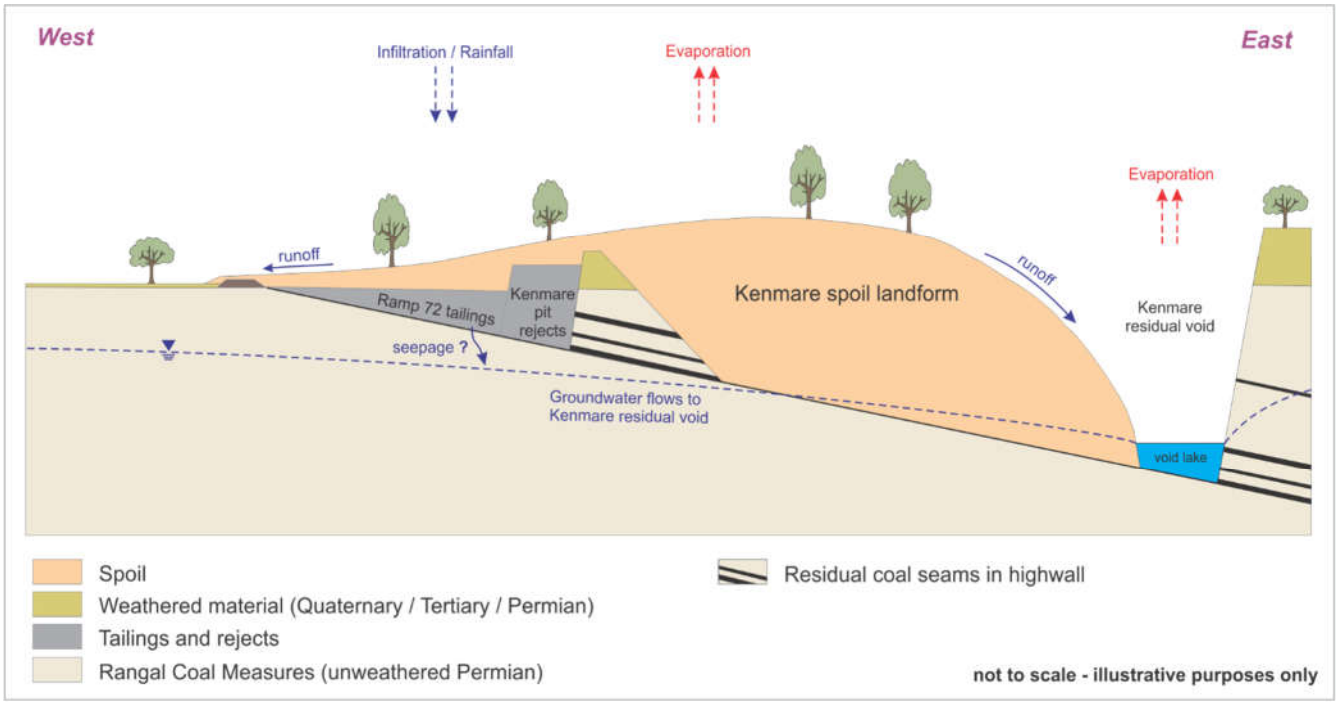
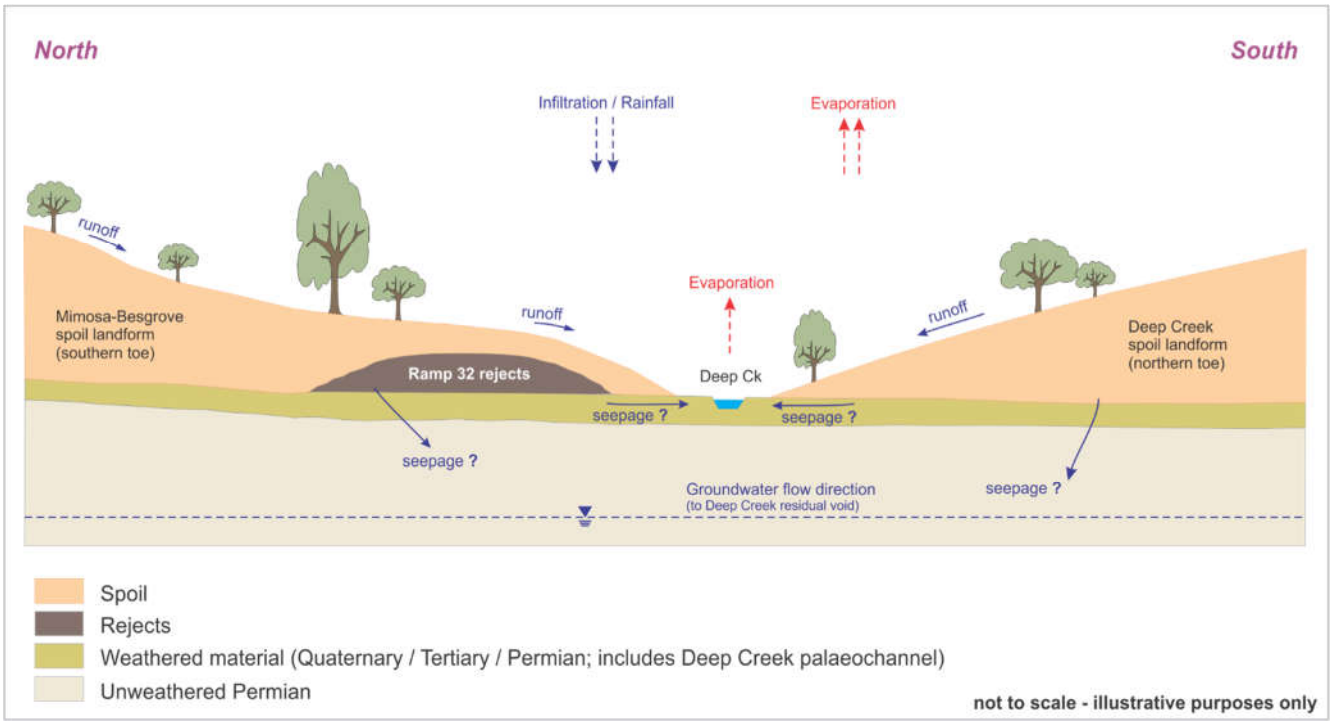


Figure 32. Post-closure Source-Pathway-Receptor (SPR) conceptual facility model (CFM) for Deep Creek [Ramp 32] rejects buried within Mimosa-Besgrove spoil landform



CFMs have also been produced for final void TSFs:

- Bonnie Doon spoil landform and residual void (TSF), with the likelihood of AMD generation from the unrehabilitated in-pit tailings rated as Probably/Likely. CFM shown at **Figure 33**.
- Ramp 74 spoil landform and residual void (Ramp 74 TSF), with the likelihood of AMD generation from the unrehabilitated in-pit tailings rated as Probably/Likely. CFM shown at **Figure 34**.

*Note: the intent of the simplified CFM illustrations shown as **Figures 27 to 34** are to conceptualise potential surface water run-off and seepage pathways between key landform domains and potential receptors. The CFM figures are not to scale and may not be a true representation of the system at each location.*

CFMs have not been developed for general rejects co-disposed (broadly distributed) throughout spoil dumps/ landforms.

Groundwater modelling, including particle tracking, shows seepage from Bonnie Doon spoil landform ultimately flows north into Ramp 8 residual void and south into Mimosa-Besgrove residual void, since these two voids are much deeper compared to Bonnie Doon void/TSF and, therefore, are much stronger groundwater sinks compared to Bonnie Doon void/TSF.

Groundwater modelling, including particle tracking, also shows seepage from Ramp74 pit area (including Ramp 74 (Laleham) spoil landform and Laleham TSF) ultimately flows southeast into Togara-North Marshmead residual void, since this void is much larger and deeper (approximately 4 times deeper) compared to Ramp 74 void and, therefore, is a much stronger groundwater sink compared to Ramp 74 void.

Figure 33. Post-closure Source-Pathway-Receptor (SPR) conceptual facility model (CFM) for Bonnie Doon spoil landform and final void TSF (Bonnie Doon TSF)

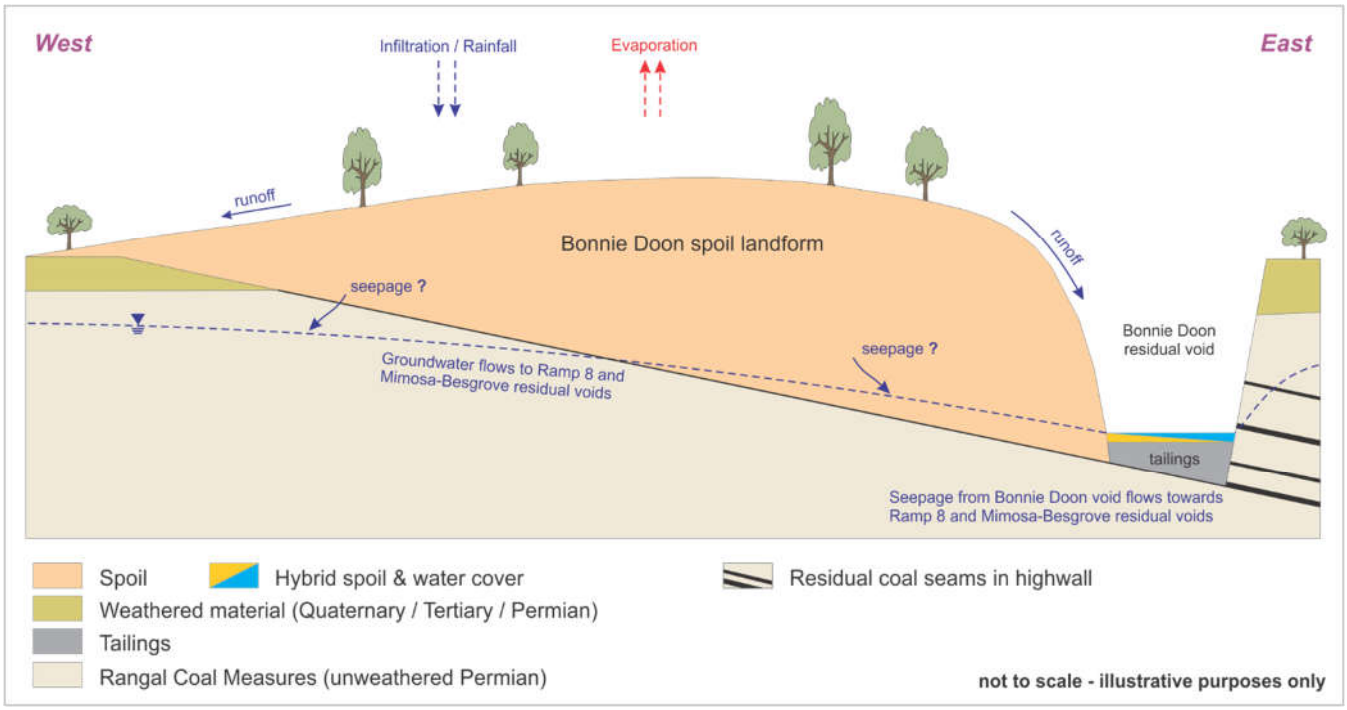
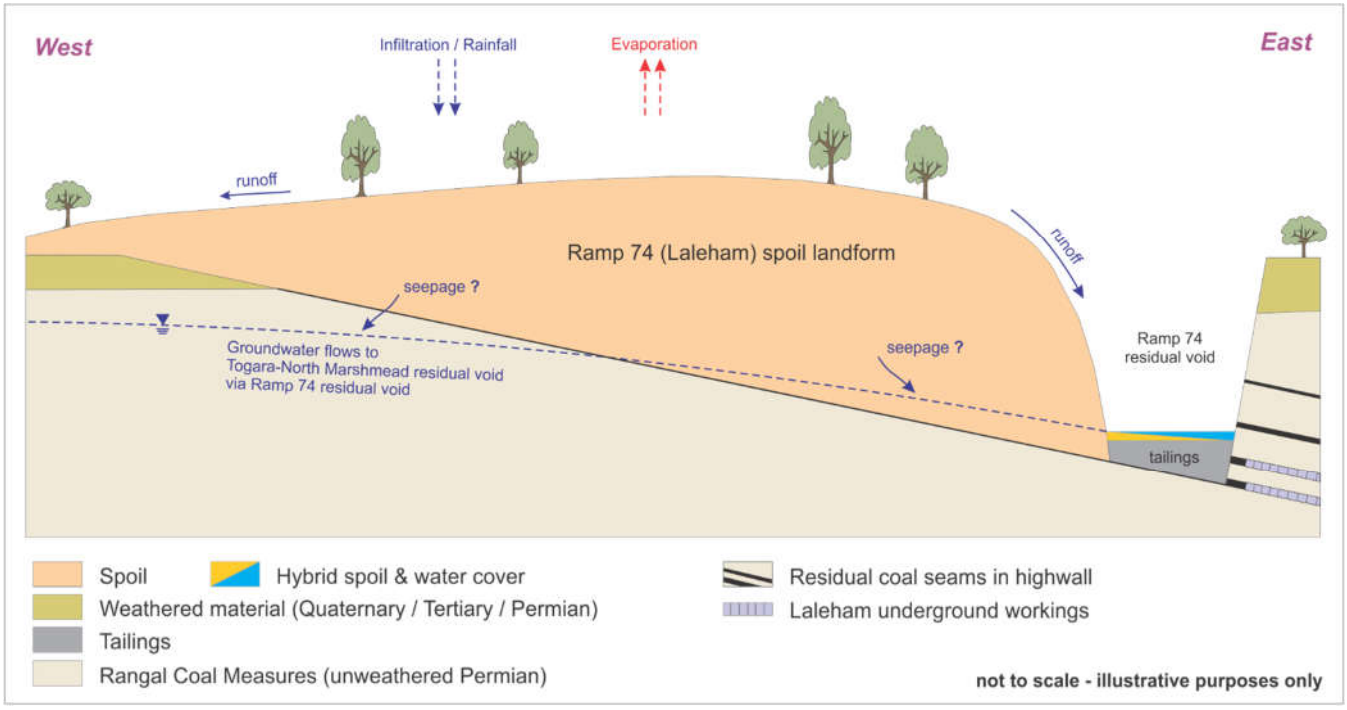


Figure 34. Post-closure Source-Pathway-Receptor (SPR) conceptual facility model (CFM) for Ramp 74 spoil landform and final void TSF (Ramp 74 TSF)



7.2.3 Summary of sources, pathways and receptors

With regard to the spoil landforms, the plausible mechanisms for AMD affected water and/or non-oxidative salinity to report to receptors are identified in Table 20.

Table 20. Sources, potential receptors and pathways between the source and receptor (post-closure) for spoil landforms

Source Landform	Potential Pathways from Source	Potential Receptors from Source
Ramp 8	Surface water [run-off]	Bonnie Doon Creek via tributary (west) / Ramp 8 residual void
	Seepage [shallow permeable strata]	Bonnie Doon Creek via tributary (west)
	Seepage [groundwater]	Ramp 8 residual void
Bonnie Doon	Surface water [run-off]	Bonnie Doon Creek via tributary (west) / Bonnie Doon residual void
	Seepage [shallow permeable strata]	Bonnie Doon Creek via tributary (west)
	Seepage [groundwater]	Primarily to Ramp 8 and Mimosa-Besgrove residual voids
Mimosa-Besgrove	Surface water [run-off]	Burngrove Creek via various tributaries (west) / Deep Creek (south) / Mimosa-Besgrove residual void
	Seepage [shallow permeable strata]	Burngrove Creek via various tributaries (west) / Deep Creek (south)
	Seepage [groundwater]	Mimosa-Besgrove residual void (+/- Ramp 30S residual void)
Deep Creek	Surface water [run-off]	Deep Creek +/- via tributaries (north and northwest) / Taurus Creek via tributaries (southwest) / Taurus Creek (south) / Deep Creek residual void
	Seepage [shallow permeable strata]	Deep Creek +/- via tributaries (north and northwest) / Taurus Creek via tributaries (southwest) / Taurus Creek (south)
	Seepage [groundwater]	Deep Creek residual void
Stewarton	Surface water [run-off]	Taurus Creek (north) / Emu Creek[1] (west) / Stewarton North residual void / Stewarton South residual void
	Seepage [shallow permeable strata]	Taurus Creek (north) / Emu Creek[1] (west)
	Seepage [groundwater]	Stewarton North residual void.
Tannyfoil	Surface water [run-off]	Emu Creek (west) / Tannyfoil residual void
	Seepage [shallow permeable strata]	Emu Creek (west)
	Seepage [groundwater]	Tannyfoil residual void (+/- to Stewarton South residual void)
Blackdown	Surface water [run-off]	Sirius Creek via western tributaries / Two Mile Gully via eastern tributaries
	Seepage [shallow permeable strata]	Sirius Creek via western tributaries / Two Mile Gully via eastern tributaries
	Seepage [groundwater]	Blackdown pit will be backfilled. Seepage via groundwater expected to report to Tannyfoil and South Ballamoo residual voids

Source Landform	Potential Pathways from Source	Potential Receptors from Source
South Ballamoo	Surface water [run-off]	Sirius Creek via western tributaries / South Ballamoo residual void
	Seepage [shallow permeable strata]	Sirius Creek via western tributaries
	Seepage [groundwater]	South Ballamoo residual void
Kenmare	Surface water [run-off]	Sirius Creek via western tributaries (west) / Kenmare residual void
	Seepage [shallow permeable strata]	Sirius Creek via western tributaries (west)
	Seepage [groundwater]	Kenmare residual void
Ramp 74	Surface water [run-off]	Sirius Creek +/- via tributaries (north and west) / Ramp 74 residual void
	Seepage [shallow permeable strata]	Sirius Creek +/- via tributaries (north and west)
	Seepage [groundwater]	Togara-North Marshmead residual void
Togara – North Marshmead	Surface water [run-off]	Sirius Creek (northwest and north) / Rockland Creek +/- tributaries (southwest and south) / Togara-North Marshmead residual void
	Seepage [shallow permeable strata]	Sirius Creek (north and west) / Rockland Creek +/- tributaries (west and south)
	Seepage [groundwater]	Togara-North Marshmead residual void
South Marshmead	Surface water [run-off]	Rockland Creek (north) / Shotover Creek tributary (south) / South Marshmead residual void
	Seepage [shallow permeable strata]	Rockland Creek (north) / Shotover Creek tributary (south)
	Seepage [groundwater]	South Marshmead residual void
Kennedy	Surface water [run-off]	Rockland Creek +/- tributaries (west and north) / Kennedy residual void
	Seepage [shallow permeable strata]	Rockland Creek +/- tributaries (west and north)
	Seepage [groundwater]	Kennedy residual void
Comet Downs East	Surface water [run-off]	Rockland Creek +/- tributaries (east and west) / Comet Downs East residual void
	Seepage [shallow permeable strata]	Rockland Creek +/- tributaries (east and west toe)
	Seepage [groundwater]	Comet Downs East residual void

With regard to the TSF and rejects landforms, the plausible mechanisms for AMD affected water and/or non-oxidative salinity to report to receptors are identified in **Table 21**.

With regard to void highwalls and end-walls as a potential source of AMD affected water and/or non-oxidative salinity, the only plausible receptor is the void, via surface water [run-off] from the void walls.

Table 21. Sources, potential receptors and pathways between the source and receptor (post-closure) for TSF and reject landforms

Sources	Potential Pathways from Source	Potential Receptors from Source
TSF landforms		
NCPP TSF	Surface water [run-off]	Deep Creek (south and east)
	Seepage [shallow permeable strata]	Deep Creek (south and east)
	Seepage [groundwater]	Deep Creek residual void
Laleham TSF	Surface water [run-off]	Sirius Creek (south)
	Seepage [shallow permeable strata]	Sirius Creek (south)
	Seepage [groundwater]	Kenmare residual void at end of mining and Togara-North Marshmead residual void post-mining (groundwater equilibrium)
Bottom Dam TSF [incl. rejects]	Surface water [run-off]	Sirius Creek (south)
	Seepage [shallow permeable strata]	Sirius Creek (south)
	Seepage [groundwater]	Kenmare residual void at end of mining and Togara-North Marshmead residual void at post-mining (groundwater equilibrium)
Rejects landform		
Ramp 36 Rejects Dump	Surface water [run-off]	Deep Creek (west and north)
	Seepage [shallow permeable strata]	Deep Creek (west and north)
	Seepage [groundwater]	Deep Creek residual void

Risk matrix and risk ratings

A residual risk rating 'heat map' (Table 22) has been adopted to assess the risks associated with SPR from the 14 spoil landforms, three TSF landforms and Ramp 36 rejects landform. In reference to the risk matrix, the SPR assessment includes the likelihood of the event occurring, the severity of the event (should it occur) and the calculated risk rating (likelihood X severity).

Table 22. Risk matrix for SPR assessment

Risk Rating = Likelihood x Severity		Severity				
		S1	S2	S3	S4	S5
Likelihood	Highly Likely	Medium	Medium to High	High	High	High
	Likely	Low to Medium	Medium	Medium to High	High	High
	Probable	Low	Low to Medium	Medium	Medium to High	High
	Unlikely	Low	Low	Low to Medium	Medium	Medium to High
	Highly Unlikely	Low	Low	Low	Low to Medium	Medium

The risk ratings for the mineral waste landforms with respect to plausible receptors is shown in **Appendix C** and report sections as follows:

Surface water receptors of landform sources

- Spoil landforms with respect to plausible surface water receptors: **Table 20** and **Appendix C Tables C1 to C14** and discussed in **Section 7.2.4**;
- TSF and rejects landforms with respect to plausible surface water receptors: **Table 21** and **Appendix C Tables C15 to C18** and discussed in **Sections 7.2.5 to 7.2.8**.

Residual void receptors of landform sources

Groundwater modelling (SLR, 2026) has shown that the residual voids will be groundwater 'sinks' in the long-term (post-closure). As such, seepage into the Permian groundwater system from any/all facilities at BWM will ultimately report into the residual voids.

- Spoil landforms with respect to residual void receptors: **Table 20** and **Appendix C Tables C19 to C22** and discussed in **Section 7.2.4**;
- TSF and rejects landforms with respect to residual void receptors: **Table 21** and **Appendix C Table C23** and discussed in **Sections 7.2.5 to 7.2.8**.

Residual void receptors of highwalls / end-walls and void floor sources

The risk ratings for the residual void highwall / end-walls and floor – for each void – with respect to final void receptors is shown in **Appendix C Table C24** and discussed in **Section 7.2.9**. The potential impact of seepage from the residual voids into the Permian groundwater aquifer is discussed in the void closure plan – refer to the main volume of the PRCP.

7.2.4 SPR assessment of spoil landforms

Source materials hazard

The spoil landforms are comprised of approximately 93 to 99% non-carbonaceous overburden/interburden with coaly and carbonaceous material (predominantly in the form of carbonaceous spoil and reject) comprising the remaining 1 to 7% of the spoil landforms. Non-

carbonaceous overburden/interburden in the Bowen Basin is widely recognised as posing a low AMD source hazard.

The AMD source hazard of rejects at BWM ranges from low to high, but overall, is generally moderate. Where rejects form part of a spoil landform they comprise less than 2% of the landform (in most cases less than 1%). Rejects within the southern end of Kenmare pit – and therefore within the Kenmare spoil landform – pose a high AMD source hazard. These rejects within the southern end of Kenmare pit are estimated to form approximately 0.5% of the Kenmare landform, however they are concentrated in a relatively small area at the base of the landform adjacent to Ramp 72 TSF.

Tailings at BWM generally pose a moderate-high to high AMD hazard and, with regard to spoil landforms, tailings will only be present in Kenmare landform (within Ramp 72 TSF). Overall, Ramp 72 tailings are estimated to comprise approximately 1.2% of the Kenmare landform, however they are concentrated in a relatively small area at the base of the landform.

Spoil materials generally have low EC values and are expected to produce non-saline to slightly saline run-off and seepage, with release of (non-oxidative) salinity rated as a low hazard. Fresh (unweathered) rejects and tailings have low to moderate EC values and are expected to produce slightly to moderately saline run-off and seepage, with release of (non-oxidative) salinity rated as a low-moderate hazard. The overall low total S and generally excess ANC of the combined mineral waste – for all spoil landforms – results in a 'Low' AMD hazard score, with AMD generation rated as 'Highly Unlikely'. Tailings and rejects specifically within Kenmare spoil landform have higher AMD hazards scores, with AMD generation rated as 'Highly Likely'. With respect to non-oxidative salinity, all spoil landforms have generally low salinity, with SD generation rated as 'Unlikely'.

Pathways

Pathways from spoil landforms to plausible surface water and groundwater (residual void) receptors are shown in **Figures 23 and 24** (Post-closure landform), **Table 20** and **Appendix C Tables C1 to C14; and C19 to C22**.

Surface water

Surface water receptors (ephemeral creeks) are located adjacent to each spoil landform – ranging from less than 100 m to approximately 600 m from landform edges. Most surface water receptors were less than 200 m from landform edges. It is plausible for surface water run-off from final rehabilitated landforms to reach these creeks. Surface water receptors greater than about 600 m from landforms were considered to be implausible receptors. Refer to **Figures 23 and 24** and **Table 20** for surface water receptors associated with each spoil landform. Tailings (e.g. Ramp 72 TSF) and rejects located within spoil landforms will be buried into spoil and therefore all run-off will likely be from general spoil (overburden/interburden) material and no tailings or rejects will be exposed to (or at risk of) surface water run-off.

Seepage / Groundwater)

The water table is expected to intersect the deeper zones of each in-pit spoil landform within the Permian coal measures (SLR, 2026). However, groundwater is captured by the residual void (as a groundwater sink). Therefore, although a direct connection is expected to exist between deeper parts of the final landforms and groundwater (the water table), this groundwater will report to the residual void – not to the broader aquifer.

As discussed in **Section 7.2.1**, it is plausible for seepage from the near-surface and unsaturated zone of the in-pit final landforms to migrate downwards into the water table. It is also plausible (however likely) that seepage may occur into discontinuous shallow permeable strata locally associated with existing creeks or palaeodrainage channels. Due to the highly discontinuous and/or not interconnected nature of shallow permeable strata at BWM, the understanding surrounding any potential link between shallow groundwater and surface water is limited. As such, whether seepage into shallow permeable strata would continue further downwards into deeper groundwater (primary aquifer) or, instead, report to nearby surface water features, is also somewhat unclear. Despite this potential limitation, the overall seepage gradient at BWM is downwards. Therefore, it is reasonably assumed that seepage from final landforms into shallow groundwater is 'Unlikely' to reach a surface water receptor.

In summary, the SPR has assumed a plausible (although unlikely) local seepage pathway may exist between a landform – such as seepage from a buried rejects dump or TSF – via shallow permeable strata into a nearby surface water receptor (ephemeral creek).

Receptors

Plausible receptors identified in this qualitative assessment include ephemeral creeks and the residual voids. Refer to **Appendix C Tables C1 to C14** for surface water receptors associated with each spoil landform and **Appendix C Tables C19 to C22** for residual void receptors.

Specific to buried Ramp 72 tailings/rejects in Kenmare spoil landform, refer to CFM **Figure 31**. Specific to buried Ramp 32 rejects in Mimosa-Besgrove spoil landform, refer to CFM **Figure 32**.

Due to the geochemical nature of the spoil landforms, the likelihood of AMD from spoil landforms to impact on the water quality of surface water receptors, residual voids or groundwater has been rated unlikely. The likelihood of non-oxidative salinity from spoil landforms to impact on the water quality of surface water receptors, residual voids or groundwater has also been rated unlikely. The overall risk rating is low.

Consideration was also made to people living in the homesteads near BWM. There are a number of homesteads in the general vicinity of BWM, however none are close to any pits or residual voids, TSFs or spoil dumps (final spoil landforms) and, as such, are considered to be implausible receptors of AMD or saline drainage for the final spoil landforms. The nearest homestead to the current mining area is '*Ausbute*' located about 1.3 km west of Burngrove pit and cannot receive run-off or seepage from Mimosa-Besgrove spoil landform.

SPR risk rating of final spoil landforms

There are plausible surface water and residual void receptors; and the run-off [and shallow seepage] pathways linking the sources (final spoil landforms) to these receptors have been identified. With respect to AMD, the overall SPR risk rating from all final spoil landforms is **Low**. With respect to non-oxidative salinity the overall SPR risk from final spoil landforms is also rated as **Low**.

Where landforms contain buried tailings and/or rejects, and especially if those buried tailings/rejects are located close to the edge of the landform and/or close to a creek, the risk rating with respect to AMD potentially making its way via shallow permeable strata into surface water features close to the buried tailings/rejects was rated as **Low to Medium**. This applies to Kenmare spoil landform (containing Ramp 72 tailings and Kenmare pit rejects) and Mimosa-Besgrove spoil landform (containing Deep Creek [Ramp 32] rejects dump).

7.2.5 SPR assessment of NCPP TSF landform

Source materials hazard

Excluding the final cover/cap to be installed over NCPP TSF, the TSF landform is currently comprised of approximately 80% tailings, with the remainder being rejects (about 19%, as embankment material) and fill material (about 1%, also as embankment material). Tailings within the TSF pose a high AMD hazard and rejects (embankments) pose a low-moderate AMD source hazard.

Source materials generally have low-moderate EC values and are expected to produce slightly to moderately saline run-off and seepage, with release of (non-oxidative) salinity rated as a low-moderate hazard. Overall, the hazard for AMD generation from the current NCPP TSF landform is 'Moderate-High' and the likelihood for AMD generation from the current landform is 'Highly Likely' (the highest 'likelihood' rating available under the applied AMD hazard scoring methodology) – noting that field evidence of AMD (as AD) exists at the facility. With respect to non-oxidative salinity, the TSF landform has a conservative hazard score of 'Probable/Likely'.

Pathways

Pathways from NCPP TSF landform to plausible surface water and groundwater (residual void) receptors are shown in **Figure 23** (Post-closure landform), **Figure 27** (CFM for NCPP TSF landform), **Table 21** and **Appendix C Table C15**.

Surface water

Deep Creek (an ephemeral creek) is located to the south and southeast of (and less than 100 m from) NCPP TSF landform and flows from west to east across the site. It is likely that surface water run-off from NCPP TSF landform will reach Deep Creek. The TSF will be covered with a spoil cover to manage the AMD source hazard, therefore all post-closure run-off from NCPP TSF landform will likely be from general spoil (overburden/interburden) material and no tailings or rejects will be exposed to (or at risk of) surface water run-off.

Shallow / Groundwater

As discussed earlier, this assessment has conservatively assumed it is plausible that seepage may occur into discontinuous shallow permeable strata associated with existing creeks or palaeodrainage channels. Whether seepage into shallow permeable strata would continue further downwards into the deeper (primary) aquifer or, instead, report through the shallow permeable strata into nearby surface water features (in this case, Deep Creek), is somewhat unclear. Despite this potential limitation, the overall seepage gradient at BWM is downwards and towards (into) residual voids – including from areas outside of a pit shell, such as NCPP TSF.

Groundwater modelling (SLR, 2026) shows that seepage from NCPP TSF landform would report to Deep Creek residual void. Therefore, it is reasonably assumed that the likelihood of seepage from NCPP TSF final landform reaching a surface water receptor (e.g. Deep Creek) via shallow groundwater is 'Unlikely'.

In summary, the SPR has assumed a plausible (although unlikely) local seepage pathway may exist between the NCPP TSF landform via shallow permeable strata into nearby ephemeral surface water receptors (such as Deep Creek).

Receptors

Plausible receptors of surface water run-off and seepage from NCPP TSF landform are shown in **Figure 23** (Post-closure landform), **Figure 27** (CFM for NCPP TSF landform), **Table 21** and **Appendix C Tables C15 and C23**.

Surface water

The only plausible surface water receptor identified in this qualitative assessment of NCPP TSF landform is ephemeral Deep Creek, located less than 100m from the TSF. This applies to potential surface water run-off and potential seepage through shallow permeable strata into the surface water receptor(s).

The rehabilitated TSF landform will have a spoil cover designed to manage the AMD hazard of the landform. The spoil cover has been conservatively assumed to pose a low-moderate AMD source hazard, based on a conservative AMD source hazard applied to general spoil. As such, the likelihood of AMD from the rehabilitated (post-closure) TSF landform to impact on the water quality of the surface water receptor(s) (via run-off or shallow seepage) has been rated unlikely. The likelihood of non-oxidative salinity from the TSF landform to impact on the water quality of the surface water receptor(s) has been rated unlikely.

Seepage / Groundwater

Seepage from NCPP TSF landform into groundwater will ultimately report to Deep Creek residual void. The likelihood of AMD and non-oxidative salinity from the rehabilitated (post-closure) TSF landform to impact on the water quality of Deep Creek residual void has been rated highly unlikely.

SPR risk rating of NCPP TSF landform

There are plausible surface water and residual void receptors; and the run-off [and shallow seepage] pathways linking the source (NCPP TSF final landform) to these receptors have been identified. Groundwater modelling (SLR, 2026) shows that seepage from NCPP TSF landform would report to Deep Creek residual void. With respect to AMD, the overall SPR risk rating from the post-closure TSF final landform is **Low to Medium**. The 'Medium' risk rating applies to AD and SD associated with seepage via shallow permeable strata. With respect to non-oxidative salinity the overall SPR risk from NCPP TSF final landform is rated as **Low**.

7.2.6 SPR assessment of Laleham TSF landform

Source materials hazard

Excluding the final cover/cap to be installed over Laleham TSF, the TSF landform is currently comprised of approximately 90% tailings, with the remainder being rejects (about 4%, partially as embankment material) and spoil/fill material (about 6%, as embankment material). The TSF has a thin spoil cover, which may require augmenting (thickening) with additional spoil during rehabilitation. Tailings and rejects within the current TSF pose a moderate-high AMD source hazard.

Source materials generally have moderate EC values and are expected to produce moderately saline run-off and seepage, with release of (non-oxidative) salinity rated as a moderate hazard. Overall, the hazard for AMD generation from the current Laleham TSF landform is 'Moderate-High' and the likelihood for AMD generation from the landform is 'Probable/Likely'. With respect to non-oxidative salinity, the TSF landform has a conservative hazard score of 'Probable/Likely'.

Pathways

Pathways from Laleham TSF landform to plausible surface water and groundwater (residual void) receptors are shown in **Figure 24** (Post-closure landform), **Figure 28** (CFM for Laleham TSF landform), **Table 21** and **Appendix C Tables C16 and C23**.

Surface water

Sirius Creek (an ephemeral creek) is located approximately 370 m south of Laleham TSF landform and flows from east to west across the site. It is plausible that surface water run-off from Laleham TSF landform could reach Sirius Creek.

The TSF is currently partially rehabilitated, however additional rehabilitation measures may be required. The rehabilitated TSF landform will have a spoil cover designed to manage the AMD hazard of the landform. Therefore, all post-closure run-off from the TSF landform will be from general spoil (overburden/interburden) material and no tailings or rejects will be exposed to (or at risk of) surface water run-off.

Seepage / Groundwater

As discussed earlier, this assessment has conservatively assumed it is plausible that seepage may occur into discontinuous shallow permeable strata associated with existing creeks or palaeodrainage channels. Whether seepage into shallow permeable strata would continue further downwards into the deeper (primary) aquifer or, instead, report through the shallow permeable strata into nearby surface water features (in this case, Sirius Creek), is somewhat unclear – especially given the distance to Sirius Creek (~370 m). Despite this potential limitation, the overall seepage gradient at BWM is downwards and towards (into) the residual voids. Therefore, it is reasonably assumed that the likelihood of seepage from Laleham TSF landform reaching a surface water feature via shallow groundwater is 'Unlikely'.

In summary, the SPR has assumed a plausible (although unlikely) local seepage pathway may exist between the Laleham TSF landform via shallow permeable strata into nearby surface water receptors (Sirius Creek).

Receptors

Plausible receptors of surface water run-off and seepage from Laleham TSF landform are shown in **Figure 24** (Post-closure landform), **Figure 28** (CFM for Laleham TSF landform), **Table 21** and **Appendix C Tables C16 and C23**.

Surface water

The only plausible surface water receptor identified in this qualitative assessment of Laleham TSF landform is ephemeral Sirius Creek, located approximately 370 m south of the TSF, with the Ramp 74 spoil landform between the TSF and the creek. This applies to potential surface water run-off and potential seepage through shallow permeable strata into Sirius Creek.

The moderate distance to Sirius Creek from the TSF landform would likely preclude surface water or shallow seepage from having any significant impact on the water quality of Sirius creek. As such, the likelihood of AMD or non-oxidative salinity from the rehabilitated TSF landform to impact on the water quality of Sirius Creek (via run-off or shallow seepage) has been rated highly unlikely.

Seepage / Groundwater

Seepage from Laleham TSF landform into groundwater will initially report to Kenmare void at the end of mining, but after groundwater levels equilibrate (well after post-closure), groundwater will ultimately report to Togara-North Marshmead residual void via Ramp 74 void. The likelihood of AMD and non-oxidative salinity from the rehabilitated (post-closure) TSF landform to impact on the water quality of Kenmare or Togara-North Marshmead residual voids has been rated highly unlikely.

SPR risk rating of Laleham TSF landform

There are plausible surface water and residual void receptors; and the run-off and shallow seepage pathways linking the source (Laleham TSF final landform) to these receptors have been identified. Groundwater modelling (SLR, 2026) shows that seepage from Laleham TSF landform would ultimately report to Togara-North Marshmead residual void via Ramp 74 void (seepage would likely report to Kenmare residual void via Ramp 74 void prior to long-term post-closure groundwater equilibrium). With respect to AMD, the overall SPR risk rating from the post-closure TSF final landform is **Low**. With respect to non-oxidative salinity the overall SPR risk from Laleham TSF final landform is also rated as **Low**.

7.2.7 SPR assessment of Bottom Dam TSF (and rejects) landform

Source materials hazard

Excluding the final cover/cap to be installed over Bottom Dam TSF (and rejects) landform, the source materials within the TSF includes tailings, which are estimated to comprise approximately 95% of the landform; and rejects, which are estimated to comprise about 4% of the landform. The TSF landform is also assumed to include a small proportion (approximately 1 %) of spoil/fill material.

Based on limited geochemical data from tailings and rejects samples obtained directly from Bottom Dam TSF, and supplemented by geochemical data for tailings and rejects samples from the broader southern BWM area (tailings and rejects originating from SCPP), tailings within the current TSF conservatively pose a moderate-high AMD source hazard and rejects conservatively pose a moderate AMD source hazard.

Source materials generally have moderate EC values and are expected to produce moderately saline run-off and seepage, with release of (non-oxidative) salinity rated as a moderate hazard. Overall, the hazard for AMD generation from the current Bottom Dam TSF landform is 'Moderate-High' and the likelihood for AMD generation from the landform is 'Probable/Likely'. With respect to non-oxidative salinity, the TSF landform has a conservative hazard score of 'Probable/Likely'.

Pathways

Pathways from Bottom Dam TSF/rejects landform to plausible surface water receptors are shown in **Figure 24** (Post-closure landform), **Figure 29** (CFM for Bottom Dam TSF/rejects landform), **Table 21** and **Appendix C Tables C17 and C23**.

Surface water

Sirius Creek (an ephemeral creek) is located approximately 750 m south of Bottom Dam area. Surface water run-off from the rehabilitated Bottom Dam TSF/rejects landform would be directed south. However – given the significant distance to Sirius Creek – it is highly unlikely that run-off and shallow seepage from the rehabilitated landform could reach Sirius Creek (most likely to infiltrate into the soil or be evaporated along the flow path).

Bottom Dam area will undergo rehabilitation, including the design and installation of a spoil cover to manage the AMD hazard of the tailings and rejects. Therefore, all post-closure run-off from the rehabilitated Bottom Dam landform will be from general spoil (overburden/interburden) material and no tailings or rejects will be exposed to (or at risk of) surface water run-off.

Seepage / Groundwater

As discussed earlier, this assessment has conservatively assumed it is plausible that seepage may occur into discontinuous shallow permeable strata associated with existing creeks or palaeodrainage channels. Whether seepage into shallow permeable strata would continue further downwards into the deeper (primary) aquifer or, instead, report through the shallow permeable strata into nearby surface water features (in this case, Sirius Creek), is somewhat unclear – especially given the distance to Sirius Creek (~750 m). Despite this potential limitation, the overall seepage gradient at BWM is downwards and towards (into) the residual voids. Therefore, it is reasonably assumed that the likelihood of seepage from Bottom Dam TSF/rejects landform reaching a surface water feature via shallow groundwater is 'Highly Unlikely'.

In summary, the SPR has assumed a plausible (although highly unlikely) local seepage pathway may exist between the Bottom Dam TSF/rejects landform via shallow permeable strata into surface water receptors (Sirius Creek).

Receptors

Plausible receptors of surface water run-off and seepage from Bottom Dam TSF/rejects landform are shown in **Figure 24** (Post-closure landform), **Figure 29** (CFM for Bottom Dam TSF/rejects landform), **Table 21** and **Appendix C Tables C17 and C23**.

Surface water

The only plausible surface water receptor identified in this qualitative assessment of Bottom Dam TSF/rejects landform is ephemeral Sirius Creek, located approximately 750 m south of Bottom Dam area. This applies to potential surface water run-off and potential seepage through shallow permeable strata into Sirius Creek.

The significant distance to Sirius Creek from the TSF/rejects landform would likely preclude surface water or shallow seepage (through shallow strata) from having any significant impact on the water quality of Sirius creek. As such, the likelihood of AMD or non-oxidative salinity from the rehabilitated TSF/rejects landform to impact on the water quality of Sirius Creek (via run-off) has been rated highly unlikely.

Seepage / Groundwater

Seepage from Bottom Dam TSF/rejects landform into groundwater will initially report to Kenmare void at the end of mining. After groundwater levels equilibrate (well after post-closure), groundwater will ultimately report to Togara-North Marshmead residual void via Ramp 74 void. The likelihood of AMD and non-oxidative salinity from the rehabilitated (post-closure) TSF/rejects landform to impact on the water quality of Kenmare, Ramp 74 or Togara-North Marshmead residual voids has been rated highly unlikely.

SPR risk rating of Bottom Dam TSF and rejects landform

There is a plausible surface water receptor (Sirius Creek); and the run-off and seepage pathways linking the source (Bottom Dam TSF/rejects final landform) to this receptor have been identified. Groundwater modelling (SLR, 2026) shows that seepage from Bottom Dam area would ultimately report to Togara-

North Marshmead residual void via Ramp 74 void (seepage would likely report to Kenmare residual void via Ramp 74 void prior to long-term post-closure groundwater equilibrium). With respect to AMD, the overall SPR risk rating from the post-closure TSF/rejects final landform is **Low**. With respect to non-oxidative salinity the overall SPR risk from Bottom Dam TSF/rejects final landform is also rated as **Low**.

7.2.8 SPR assessment of Ramp 36 rejects landform

Source materials hazard

Excluding the final cover/cap to be installed over Ramp 36 rejects dump, the rejects landform is currently comprised of approximately 98% rejects, with the remainder being fill material (estimated to be about 2%). Rejects within the dump pose a Moderate-High AMD hazard.

Source materials (essentially all rejects) have moderate EC values and are expected to produce moderately saline run-off and seepage, with release of (non-oxidative) salinity rated as a moderate hazard. Overall, the hazard for AMD generation from the current Ramp 36 rejects landform is 'Moderate-High' and the likelihood for AMD generation from the landform is 'Probable/Likely'. With respect to non-oxidative salinity, the TSF landform has a conservative hazard score of 'Probable/Likely'.

Pathways

Pathways from Ramp 36 rejects landform to plausible surface water and groundwater (residual void) receptors are shown in **Figure 23** (Post-closure landform), **Figure 30** (CFM for Ramp 36 rejects landform), **Table 21** and **Appendix C Tables C18 and C23**.

Surface water

Deep Creek (an ephemeral creek) is located to the north of (and less than 100 m from) Ramp 36 rejects landform and flows from west to east across the site. It is likely that surface water run-off from the rejects landform will reach Deep Creek. The rejects dump will be covered with a spoil cover to manage the AMD source hazard, therefore all post-closure run-off from the rejects landform will likely be from general spoil (overburden/interburden) material and no rejects will be exposed to (or at risk of) surface water run-off.

Shallow / Groundwater

As discussed earlier, this assessment has conservatively assumed it is plausible that seepage may occur into discontinuous shallow permeable strata associated with existing creeks or palaeodrainage channels. Whether seepage into shallow permeable strata would continue further downwards into the deeper (primary) aquifer or, instead, report through the shallow permeable strata into nearby surface water features (in this case, Deep Creek), is somewhat unclear. Despite this potential limitation, the overall seepage gradient at BWM is downwards and towards (into) residual voids – including from areas outside of a pit shell, such as Ramp 36 rejects landform.

Groundwater modelling (SLR, 2026) shows that seepage from Ramp 36 rejects landform would report to Deep Creek residual void. Therefore, it is reasonably assumed that the likelihood of seepage from the final rejects landform reaching a surface water receptor (e.g. Deep Creek) via shallow groundwater is 'Unlikely'.

In summary, the SPR has assumed a plausible (although unlikely) local seepage pathway may exist between Ramp 36 rejects landform via shallow permeable strata into nearby ephemeral surface water receptors (such as Deep Creek).

Receptors

Plausible receptors of surface water run-off and seepage from Ramp 36 rejects landform are shown in **Figure 23** (Post-closure landform), **Figure 30** (CFM for Ramp 36 rejects landform), **Table 21** and **Appendix C Tables C18 and C23**.

Surface water

The only plausible surface water receptor identified in this qualitative assessment of Ramp 36 rejects landform is ephemeral Deep Creek, located less than 100m from the TSF. This applies to potential surface water run-off and potential seepage through shallow permeable strata into the surface water receptor(s).

The rehabilitated rejects landform will have a spoil cover designed to manage the AMD hazard of the landform. The spoil cover has been conservatively assumed to pose a low-moderate AMD source hazard, based on a conservative AMD source hazard applied to general spoil. As such, the likelihood of AMD from the rehabilitated (post-closure) rejects landform to impact on the water quality of the surface water receptor(s) (via run-off or shallow seepage) has been rated unlikely. The likelihood of non-oxidative salinity from the rejects landform to impact on the water quality of the surface water receptor(s) has been rated unlikely.

Seepage / Groundwater

Seepage from Ramp 36 rejects landform into groundwater will ultimately report to Deep Creek residual void. The likelihood of AMD and non-oxidative salinity from the rehabilitated (post-closure) rejects landform to impact on the water quality of Deep Creek residual void has been rated highly unlikely.

SPR risk rating of Ramp 36 rejects landform

There are plausible surface water and residual void receptors; and the run-off and shallow seepage pathways linking the source (Ramp 36 rejects final landform) to these receptors (Deep Creek) have been identified. Groundwater modelling (SLR, 2026) shows that seepage from Ramp 36 rejects landform would report to Deep Creek residual void. With respect to AMD, the overall SPR risk rating from the post-closure rejects final landform is **Low to Medium**. The 'Medium' risk rating applies to AD and SD associated with seepage via shallow permeable strata. With respect to non-oxidative salinity the overall SPR risk from the post-closure rejects final landform is also rated as **Low**.

7.2.9 SPR assessment of residual voids

Source materials hazard

The surfaces of residual void walls are comprised of approximately 88% to 95% non-carbonaceous overburden/ interburden, less than 1% to 6% carbonaceous overburden/interburden (incl. sub-economic seams reporting to waste) and about 2% to 7% coal (seams). The proportion of weathered material in the current (and proposed future) pit/void walls varies throughout the site, ranging from approximately 17% to 25% in the northern pits/voids and approximately 11% to 79% in the southern pits/voids. Fresh and weathered non-carbonaceous overburden/interburden material in the Bowen Basin is widely recognised as posing a low AMD risk. Coal seams at BWM pose a low-moderate AMD risk.

Overall, the hazard for AMD generation from residual void walls is 'Low' and the likelihood for AMD generation from residual void walls is 'Unlikely'. The expression of AMD (if at all) from some highwall and end-wall material is likely to be localised.

Generally, void wall materials have low EC values, with release of (non-oxidative) salinity rated as a low hazard.

The floor of Bonnie Doon and Ramp 74 pits (voids) is tailings, of which approximately 46% (for Bonnie Doon) and 72% (for Ramp 74) is conservatively estimated to be PAF. These two in-pit TSFs (tailings voids) pose a moderate to moderate-high AMD hazard – which does not take into account likely AMD-mitigating factors, such as tailings flooding or the tailings being covered/capped with a suitable spoil and/or water cover. Assuming the tailings would be submerged/covered/capped as proposed, the void floor (tailings) would be expected to pose a low AMD hazard.

The floor of all other voids is comprised of P and L (Lower) seam and is conservatively estimated to comprise less than 5% PAF coal – assuming 100% of the floor is coal and not some other material. In reality, all or most of the coal will be mined out and the void floor would not be expected to be dominated by coal. The void floors, as conservatively described, pose a low-moderate AMD hazard – which does not take into account likely AMD-mitigating factors, such as void floor flooding. Assuming the void floors would be submerged (flooded) as predicted by groundwater modelling, the void floor would be expected to pose a low AMD hazard.

Pathways

Surface water

There are no plausible pathways between the residual voids and surface water. For each void, surface water run-off from the void walls will report to the void.

Seepage / Groundwater

The residual voids will act as groundwater sinks and the water table will intersect the deeper zones of the residual voids, resulting in the formation of a relatively small void lake in each void (SLR, 2026) that will submerge the void floor and lower section of the void walls. At Bonnie Doon and Ramp 74 voids (TSFs), the post-closure water table will intersect and submerge most of the tailings. These in-pit tailings will be capped/covered to manage the AMD source hazard. For each void, seepage from the spoil landform and run-off from the void walls will report to the residual void.

Receptors

Modelling undertaken by SLR (2026) shows the residual voids to be 'sinks' – receiving surface water run-off and seepage from spoil landforms and surface water run-off from void walls. Each residual void is expected to receive inflow from the Permian groundwater aquifer. The water quality of the void and potential impact of water seeping, if any, from the residual voids into the Permian groundwater aquifer is discussed in the void closure plan – refer to the main volume of the PRCP.

Excluding Bonnie Doon and Ramp 74 voids (TSFs), the 'coal' floor of all other residual voids will be covered post-closure by water as rainfall and groundwater reporting to the void will form a void lake. As such, PAF coal will no longer be exposed to atmospheric conditions and the risk of AMD being generated is greatly reduced.

Bonnie Doon and Ramp 74 voids contain tailings; and modelling shows the tailings will eventually be fully or partially covered post-closure by water as rainfall and groundwater report to the void. During rehabilitation, the tailings will be capped/covered such that tailings will no longer be exposed to atmospheric conditions and the risk of AMD being generated from tailings is greatly reduced – particularly during the early years post-closure as water levels in these two voids recover.

The likelihood of undiluted salinity or AMD from a flooded post-closure residual void floor (or covered/capped/flooded tailings floor) to impact on residual void water quality to any significant degree has been rated unlikely.

SPR risk rating of residual voids

The final receptor for seepage from the spoil landform (for each spoil landform) and run-off from the highwall / end-walls (of each void) is the void lake / residual void. The AMD assessment has found that it's unlikely that undiluted salinity or AMD from a flooded post-closure residual void floor (including capped/covered/flooded tailings floor) would impact on residual void water quality to any significant degree, as other processes such as evapo-concentration are the key drivers of void lake water quality. Therefore, the AMD SPR risk rating on the overall water quality of the residual voids is **Low to Low-Medium** [**Appendix C Table C24**]. A "Low to Medium" risk rating has been conservatively applied to the risk of AD and/or NMD/SD due to the AMD risk associated with tailings within Bonnie Doon and Ramp 74 voids.

Water reporting to residual voids is expected to remain within the residual voids (excluding evaporative loss). Modelling undertaken by SLR (2026) shows that seepage from the void lake (of each void) into groundwater, if any, would be limited.

8 Management and Rehabilitation Measures

The assessment has found that the environmental risks posed by spoil landforms likely to be present at closure are generally low. As such – for most spoil landforms – no specific AMD management measures (e.g. alkaline amendment or engineered capping systems) are expected to be required to manage mineral wastes during rehabilitation and closure – outside of operational mixing/burial of PAF waste amongst NAF waste, spoil placement and landform reshaping activities already proposed (refer below and to the main volume of the PRCP).

The AMD source hazard associated with Ramp 72 tailings and Kenmare pit rejects buried within Kenmare landform is moderate-high to high and, as such, rehabilitation of tailings and rejects within Kenmare ramp/pit will require specific AMD management measures during future mining and rehabilitation to manage the AMD hazard of these materials. Once rehabilitated, the post-closure environmental risk posed by Kenmare spoil landform is expected to decrease.

The landform domain AMD hazard posed by NCPP TSF, Laleham TSF and Bottom Dam TSF is moderate-high; and for Ramp 36 Rejects dump is also moderate-high. These stand-alone landforms will require specific AMD management measures to manage these facilities post-closure.

The AMD hazard posed by tailings in Bonnie Doon in-pit TSF is moderate-high and for Ramp 74 in-pit TSF is moderate. As such, in-pit tailings will also require specific AMD management measures to manage these voids post-closure.

Decommissioning and rehabilitation activities related to mineral waste will be addressed as part of the milestone criteria for infrastructure, remediation of contaminated land, landform design, surface preparation and revegetation, where necessary.

Proposed mineral waste management and rehabilitation activities of relevance to this waste characterisation report comprise the following actions. Refer to the main volume of the PRCP and Henderson Geotech (2024) for detailed information.

- Pits: most will remain as residual voids under 15 groups:
    - Ramp 8 void
    - Bonnie Doon void (in-pit TSF)
    - Mimosa-Besgrove void
    - Ramp 30S void
    - Deep Creek void
    - Stewarton North void
    - Stewarton South void
    - Tannyfoil void
    - South Ballamoo void
    - Kenmare void (in-pit TSF)
    - Ramp 74 [Laleham] void (in-pit TSF)
    - Togara-North Marshmead void
    - South Marshmead void
    - Kennedy void
    - Comet Downs East void
- Spoil dumps: will be reshaped into 14 final spoil landforms – mostly related to their respective voids listed. Stewarton pit will be mined into two voids (Stewarton North and Stewarton South). Blackdown pit will be backfilled, leaving Blackdown spoil landform without an associated residual void. Spoil from Ramp 30S pit will form part of Mimosa-Besgrove spoil landform. After reshaping, all spoil dumps will be seeded.
- Bonnie Doon in-pit TSF will be covered by a spoil and water cover (hybrid cover). The optimal design and thickness of cover to manage the AMD hazard of Bonnie Doon in-pit TSF (tailings) will be determined following further assessment prior to covering.

- Ramp 74 in-pit TSF will be covered by a spoil and water cover (hybrid cover). The optimal design and thickness of cover to manage the AMD hazard of Ramp 74 in-pit TSF (tailings) will be determined following further assessment prior to covering.
- NCPP TSF (out-of-pit; above ground; stand-alone) will be covered by an engineered spoil cover. The optimal design and thickness of spoil cover to manage the AMD hazard of the out-of-pit NCPP TSF will be determined following further assessment prior to covering.
- Laleham TSF (in-pit; above ground; stand-alone) will be covered by spoil. The optimal design and thickness of spoil cover to manage the AMD hazard of the TSF will be determined following further assessment prior to covering.
- Ramp 72 in-pit TSF will be covered by spoil within Kenmare spoil landform. The optimal design and thickness of spoil cover to manage the AMD hazard of the in-pit TSF will be determined following further assessment prior to covering.
- Bottom Dam TSF/rejects (out-of-pit; above ground; stand-alone). Rejects currently on ROM 3 will be relocated onto Bottom Dam TSF forming a rejects cap, which will then be covered by a spoil cover. The optimal design and thickness of spoil cover to manage the AMD hazard of Bottom Dam TSF/rejects area will be determined following further assessment prior to covering.
- Kenmare in-pit rejects will be covered by spoil within Kenmare spoil landform. The optimal design and thickness of spoil cover to manage the AMD hazard of these in-pit rejects will be determined following further assessment prior to covering.
- Ramp 36 rejects (above ground; stand-alone) will be covered by a spoil cover. The optimal design and thickness of spoil cover to manage the AMD hazard of the rejects dump will be determined following further assessment prior to covering.
- All other rejects (in-spoil disposal): Managed during operations (disposed within spoil) and progressively covered by spoil. No additional remediation for the rejects (at closure) is required. The optimal thickness of spoil cover to manage the AMD hazard of rejects will be determined following further assessment prior to covering.
- ROM pads: Remove remnant coal from ROM pads and dispose within spoil. All former ROM pads will be reshaped, covered with soil, ripped and seeded.
- Coal stockpiles: Remove remnant coal from coal stockpile pads and dispose within spoil. Cover with suitable soil material, rip and seed.

9 Forward Work Program

The environmental geochemical characterisation and assessment of mineral waste samples outlined in this report is representative of the mineral waste materials likely to require rehabilitation at closure. However, BWM will continue to undertake sampling of likely mineral waste materials (and subsequent characterisation and assessment of those samples) during operations and into decommissioning – to validate the findings of the current assessment, ensure the risks continue to be understood and the management measures proposed are commensurate with the risks. Where required, management measures will be revised and implemented.

Further work may also be required prior to closure to better understand the relationship between shallow and deeper groundwater at BWM and between shallow groundwater and surface water systems at BWM.

10 References

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Appendix A – Geological Sections

Pit and void long-sections

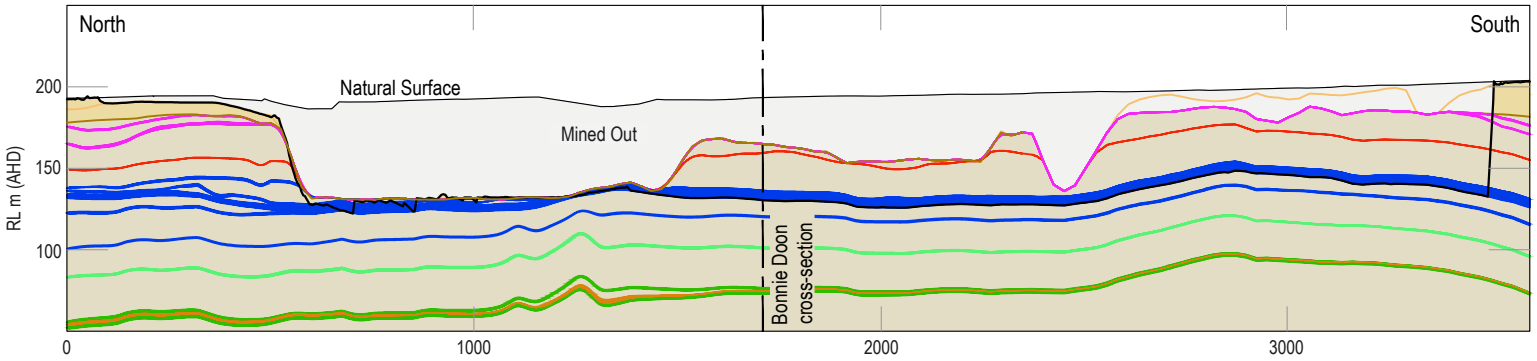
- Figure A1 Bonnie Doon, Mimosa and Sagittarius pits
- Figure A2 Burngrove, Airstrip and Besgrove North pits
- Figure A3 Ramp 30S, Deep Creek and Stewarton North pits
- Figure A4 Tannyfoil, Wilpeena and Blackdown pits
- Figure A5 Ballamoo North / Terang, Ramp 74 and Togara pits; and Kenmare highwall
- Figure A6 Marshmead pit and Togara-North Marshmead void
- Figure A7 South Marshmead, Kennedy and Comet Downs East voids

Pit and void cross-sections

- Figure A8 Bonnie Doon, Mimosa and Sagittarius pits
- Figure A9 Burngrove, Airstrip and Besgrove North pits
- Figure A10 Deep Creek pit at Ramp 34 and Ramp 38, and Stewarton North pit
- Figure A11 Tannyfoil, Wilpeena and Blackdown pits
- Figure A12 Ballamoo North, Terang pit and Kenmare pit
- Figure A13 Ramp 74 pit, Togara-North Marshmead pit/void and Marshmead pit
- Figure A14 Proposed pits: South Marshmead, Kennedy and Comet Downs East

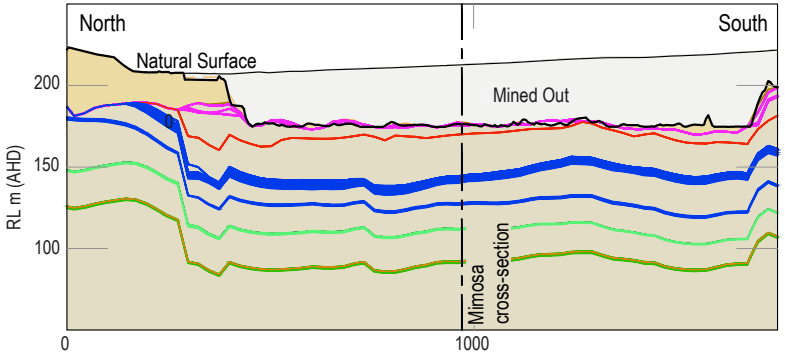
LONG-SECTION | Bonnie Doon Pit

Viewed Looking East (Vertical Exaggeration x4.0)



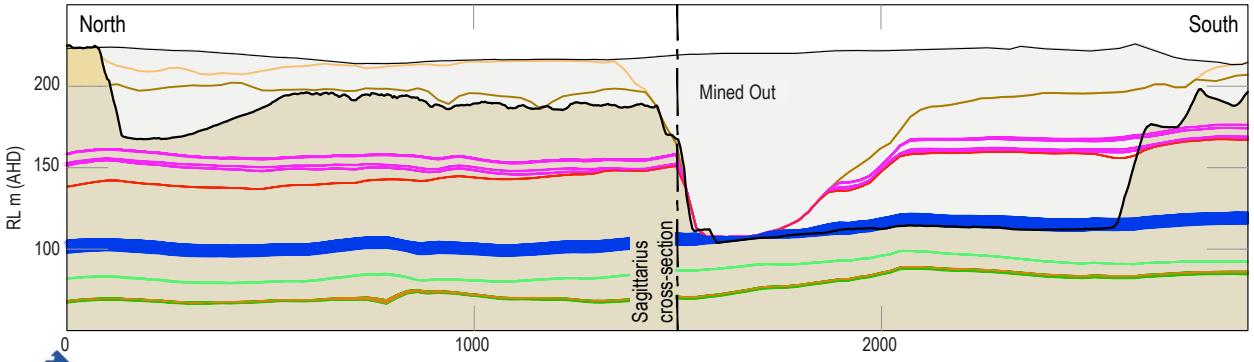
LONG-SECTION | Mimosa Pit

Viewed Looking East (Vertical Exaggeration x4.0)



LONG-SECTION | Sagittarius Pit

Viewed Looking East (Vertical Exaggeration x4.0)



Legend

- Natural Surface
- Base of Tertiary
- Base of Weathering
- Current Pit Shell

Coal Seams

- T Seam Group
- MR Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- Yarabee Tuff
- PS Seam Group

Vertical Scale

0 100m

Horizontal Scale

0 400m

(V/H = 4:1)

WHITEHAVEN

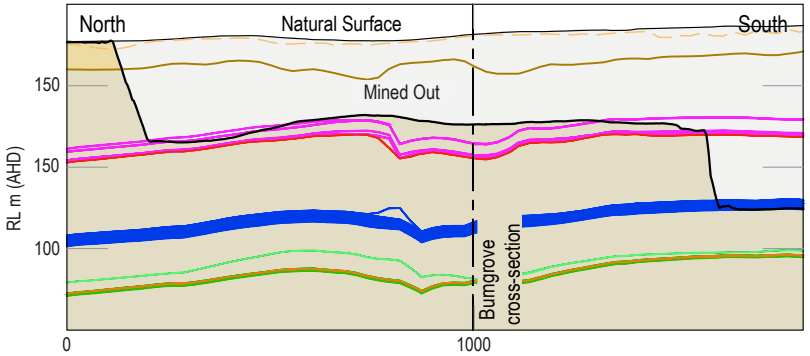
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Pit highwall long-sections

Figure **A1**

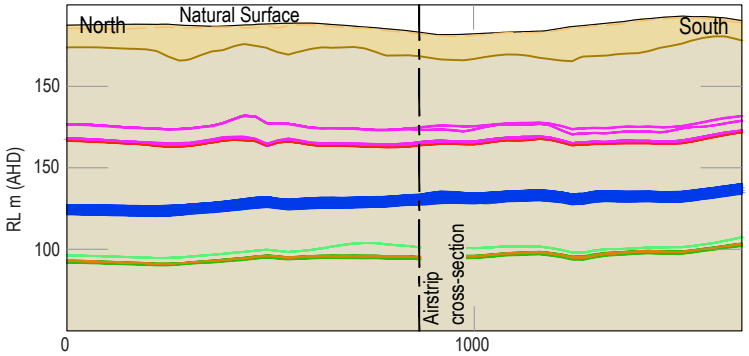
LONG-SECTION | Burngrove Pit

Viewed Looking East (Vertical Exaggeration x4.0)



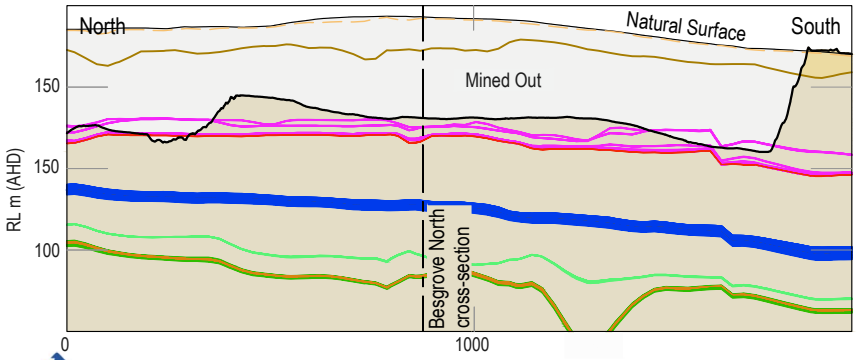
LONG-SECTION | Airstrip Pit

Viewed Looking East (Vertical Exaggeration x4.0)



LONG-SECTION | Besgrove North Pit

Viewed Looking East (Vertical Exaggeration x4.0)



Legend

- Natural Surface
- Base of Tertiary
- Base of Weathering
- Current Pit Shell

Coal Seams

- T Seam Group
- MR Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- Yarabee Tuff
- PS Seam Group

Vertical Scale

0 — 100m

Horizontal Scale

0 — 400m

(V/H = 4:1)

WHITEHAVEN

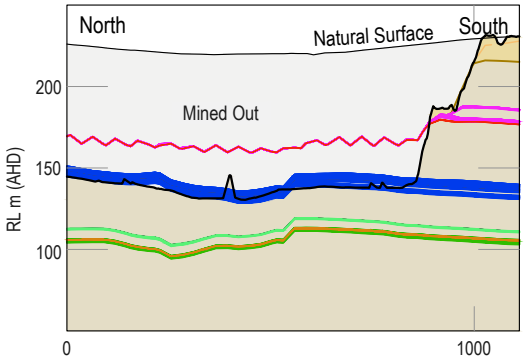
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Pit highwall long-sections

Figure **A2**

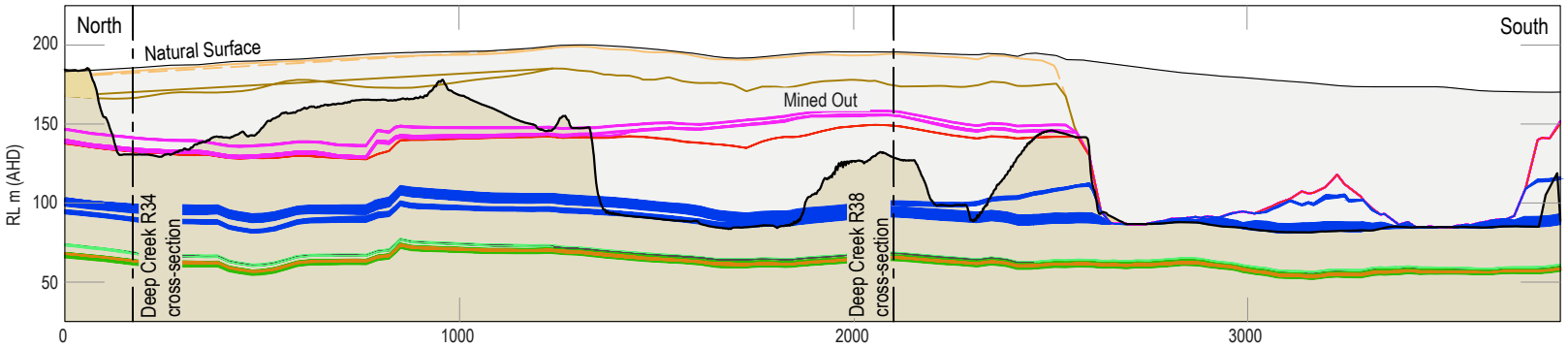
LONG-SECTION | Ramp 30S Pit

Viewed Looking East (Vertical Exaggeration x4.0)



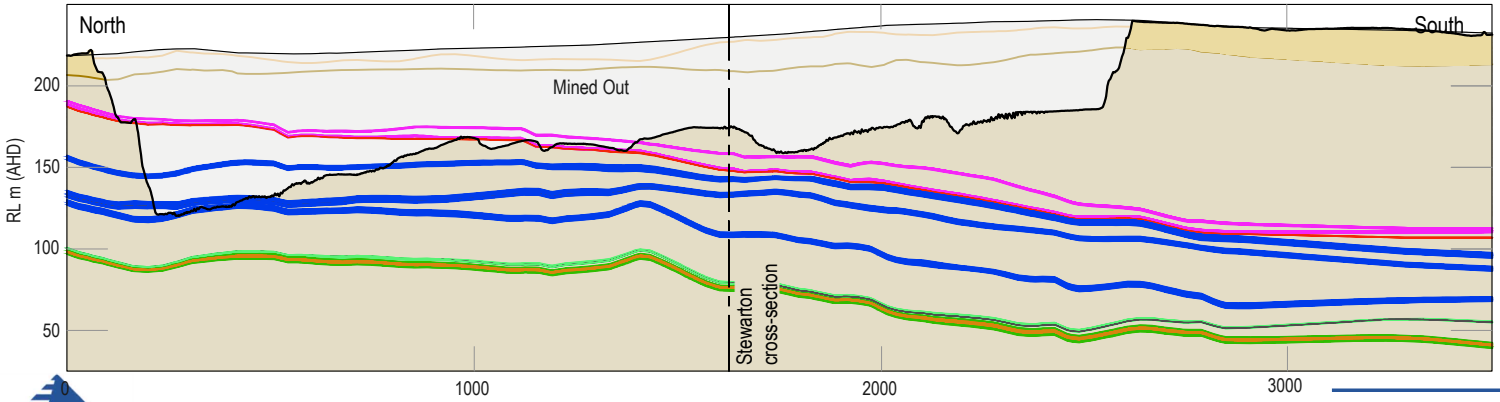
LONG-SECTION | Deep Creek Pit

Viewed Looking North East (Vertical Exaggeration x4.0)



LONG-SECTION | Stewarton Pit

Viewed Looking North East (Vertical Exaggeration x4.0)



Legend

- Natural Surface
- Base of Tertiary
- Base of Weathering
- Current Pit Shell

Coal Seams

- T Seam Group
- MR Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- Yarabee Tuff
- PS Seam Group

Vertical Scale

0 — 100m

Horizontal Scale

0 — 400m

(V/H = 4:1)

WHITEHAVEN

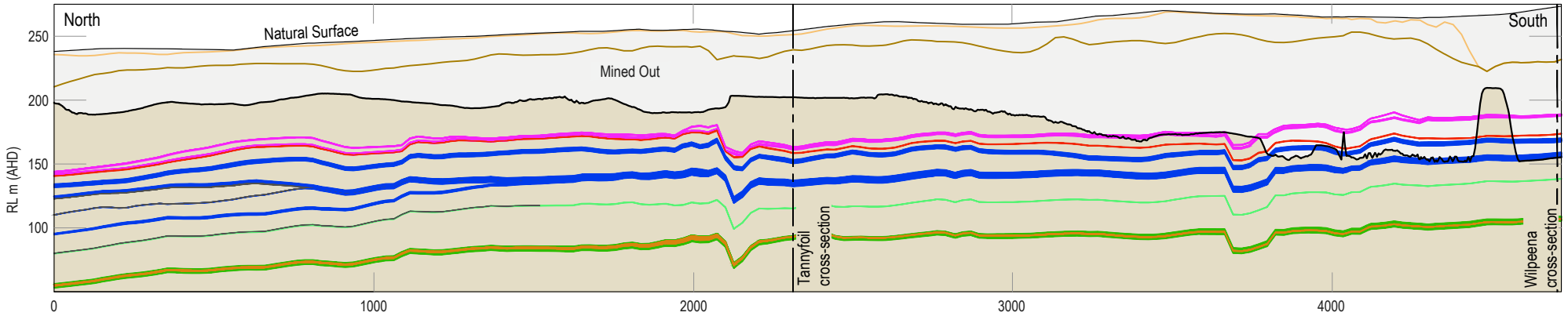
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Pit highwall long-sections

Figure **A3**

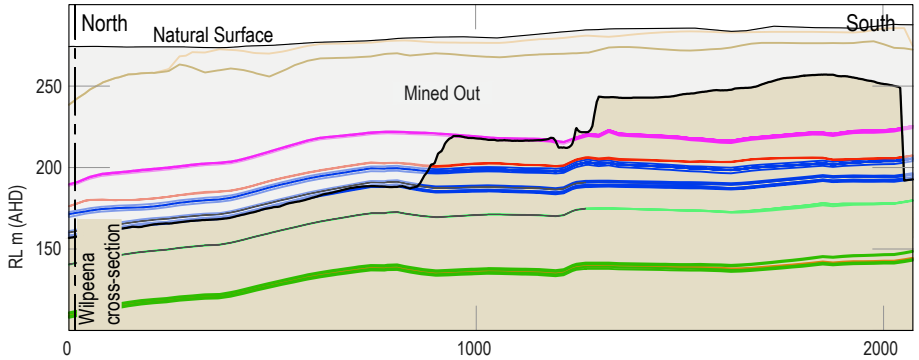
LONG-SECTION | Tannyfoil Pit

Viewed Looking East (Vertical Exaggeration x4.0)



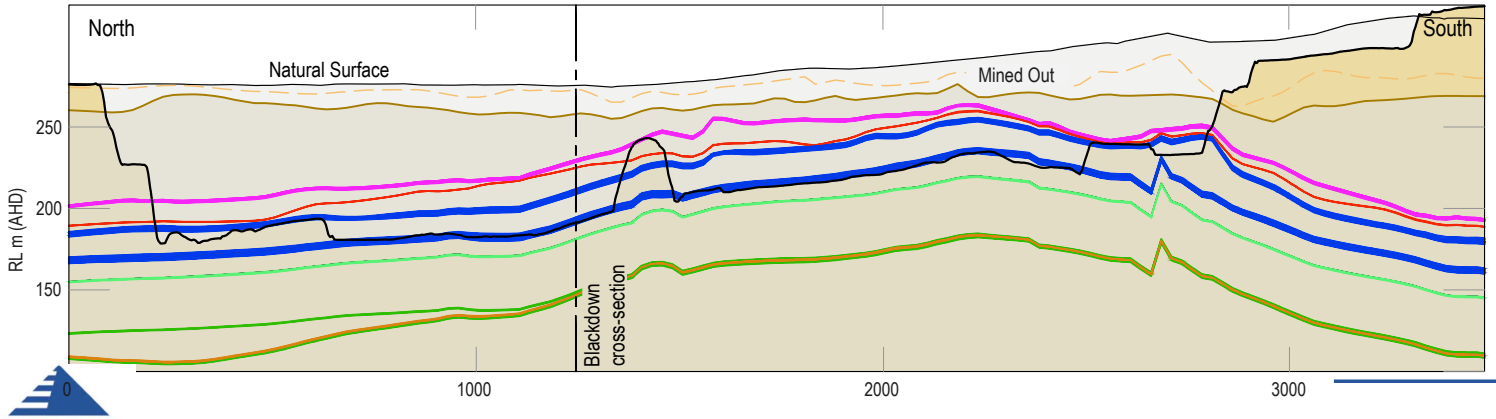
LONG-SECTION | Wilpeena Pit

Viewed Looking East (Vertical Exaggeration x4.0)



LONG-SECTION | Blackdown Pit

Viewed Looking East (Vertical Exaggeration x4.0)



Legend

- Natural Surface
- Base of Tertiary
- Base of Weathering
- Current Pit Shell

Coal Seams

- T Seam Group
- MR Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- Yarabee Tuff
- PS Seam Group

Vertical Scale

0 — 100m

Horizontal Scale

0 — 400m

(V/H = 4:1)

WHITEHAVEN

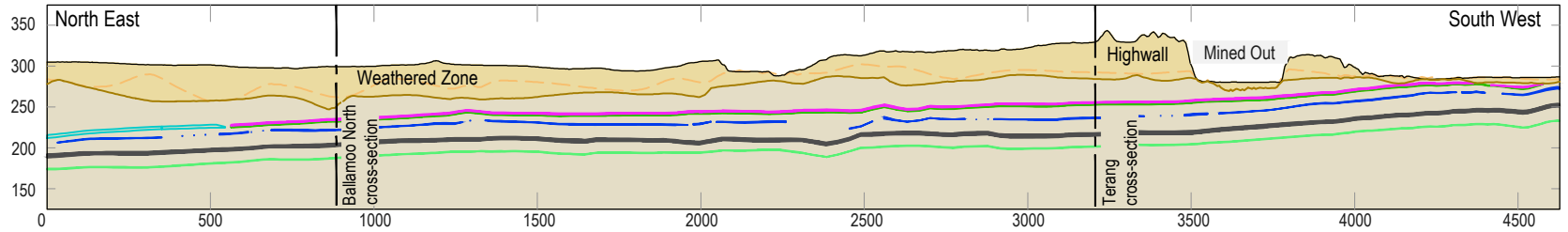
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Pit highwall long-sections

Figure **A4**

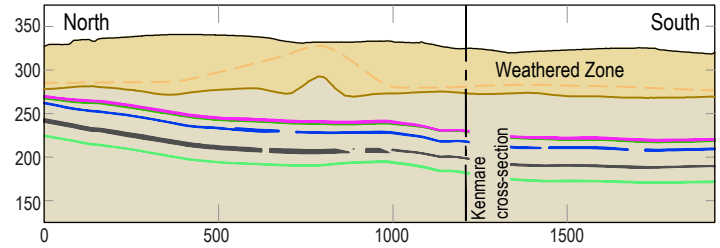
LONG-SECTION | Ballamoo North and Terang (Ballamoo South) Pit

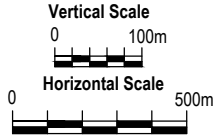
Viewed Looking South-East (Vertical Exaggeration x2.5)

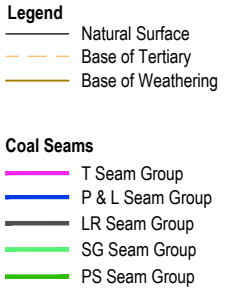


LONG-SECTION | Kenmare void

Viewed Looking East (Vertical Exaggeration x2.5)

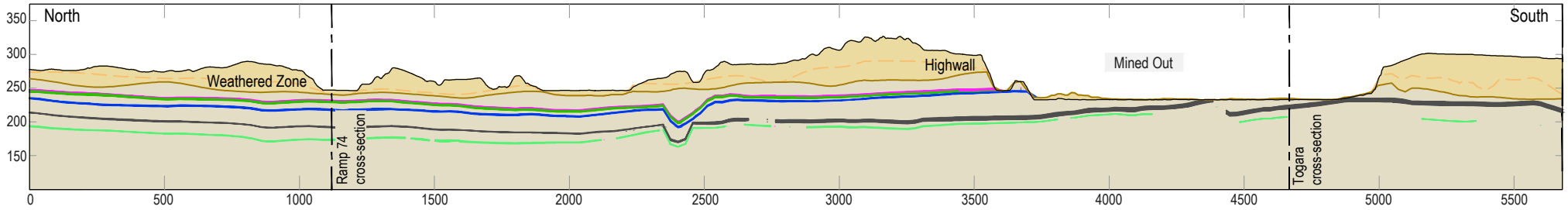






LONG-SECTION | Ramp 74 (Laleham) -Togara Pit

Viewed Looking East (Vertical Exaggeration x2.5)



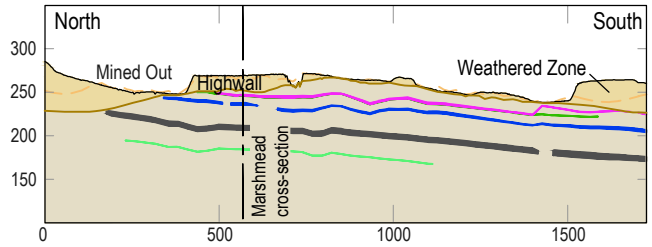
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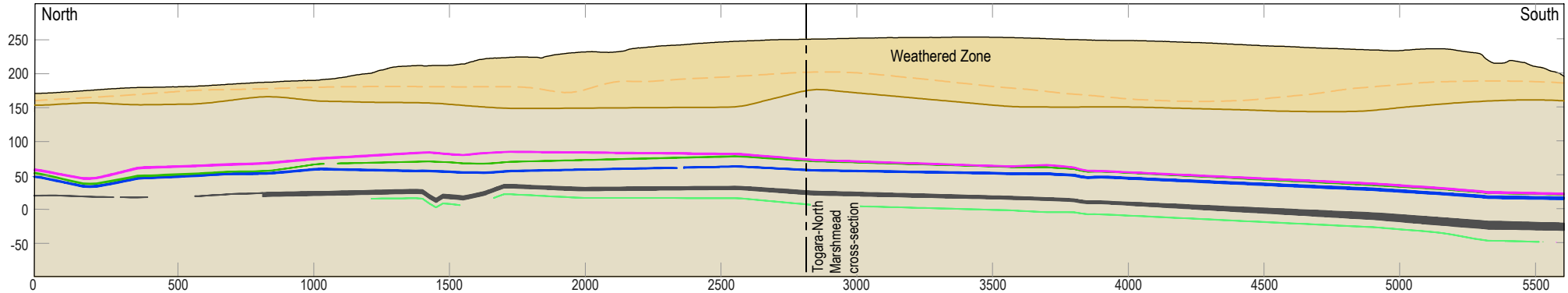
Pit highwall long-sections

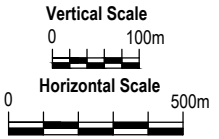
Figure **A5**

LONG-SECTION | Marshmead Pit
Viewed Looking North-East (Vertical Exaggeration x2.5)



LONG-SECTION | Togara-North Marshmead void
Viewed Looking East (Vertical Exaggeration x2.5)





Legend
- Natural Surface
- Base of Tertiary
- Base of Weathering

Coal Seams
- T Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- PS Seam Group

WHITEHAVEN

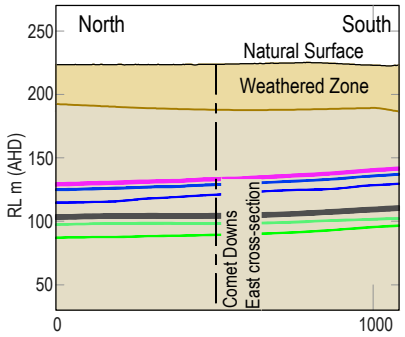
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Pit highwall long-sections

Figure **A6**

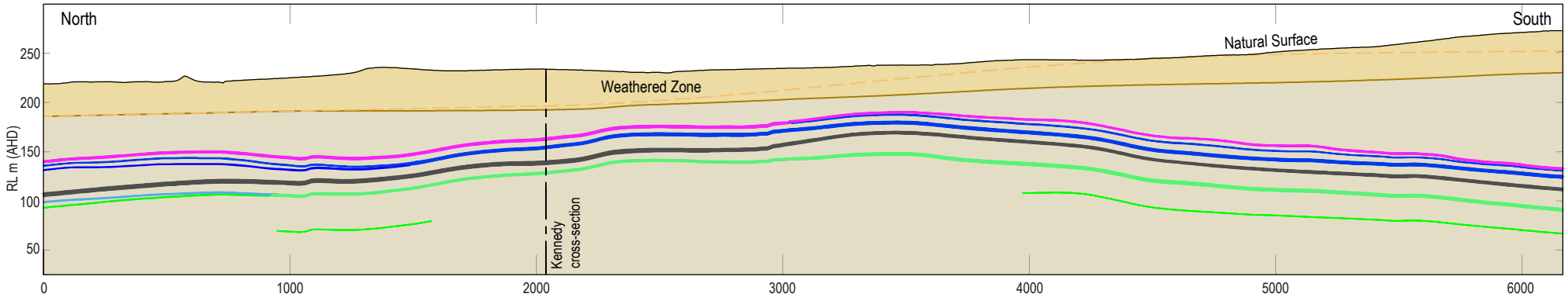
LONG-SECTION | Comet Downs East void

Viewed Looking East (Vertical Exaggeration x4.0)



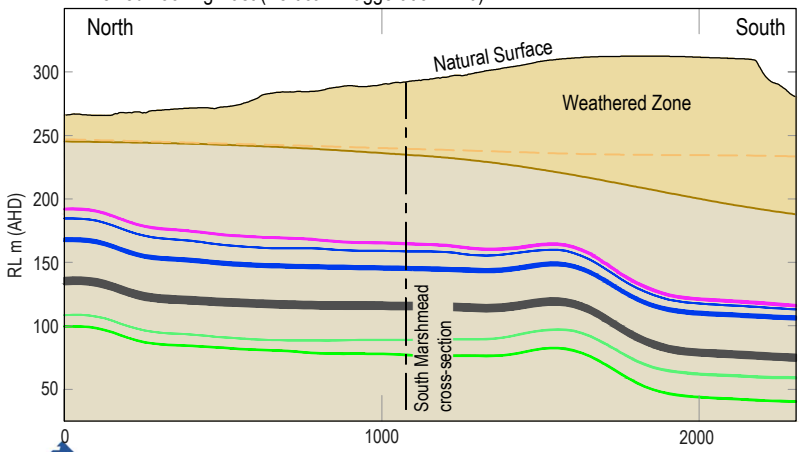
LONG-SECTION | Kennedy void

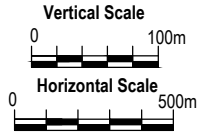
Viewed Looking East (Vertical Exaggeration x4.0)



LONG-SECTION | South Marshmead void

Viewed Looking East (Vertical Exaggeration x4.0)





Legend

- Natural Surface
- Base of Tertiary
- Base of Weathering

Coal Seams

- T Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- PS Seam Group

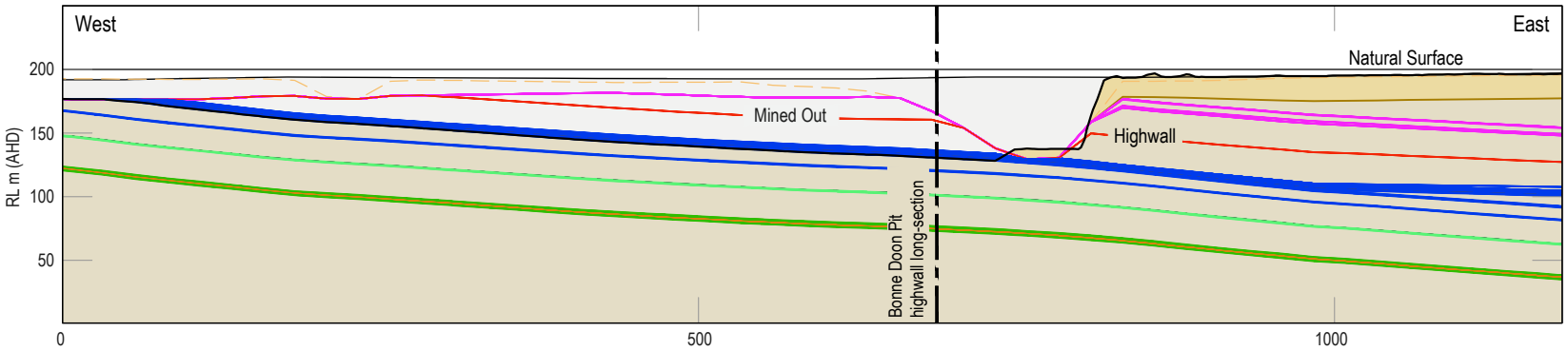
WHITEHAVEN

Minserve CAD File: Bhpb008m12-MDL Areas.dwg

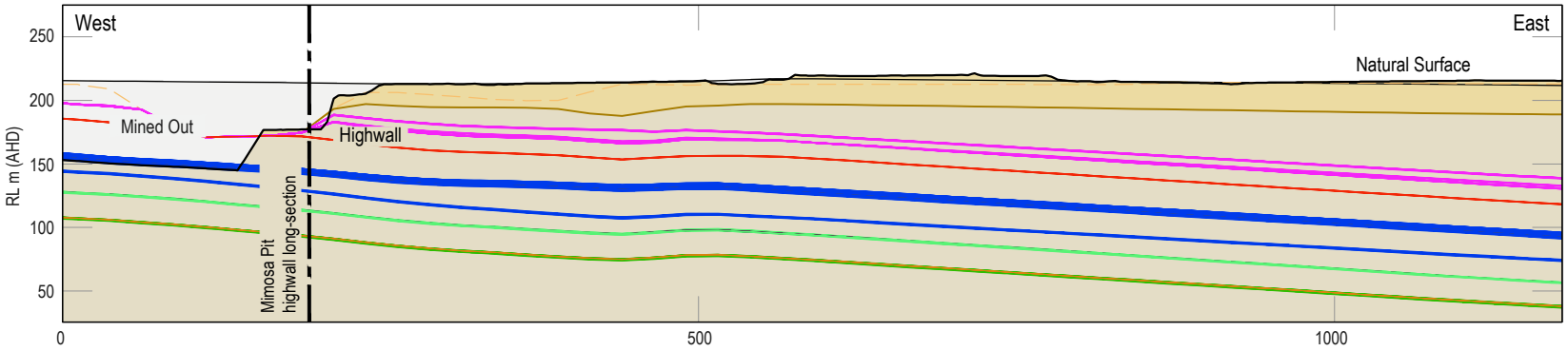
Void highwall long-sections

Figure **A7**

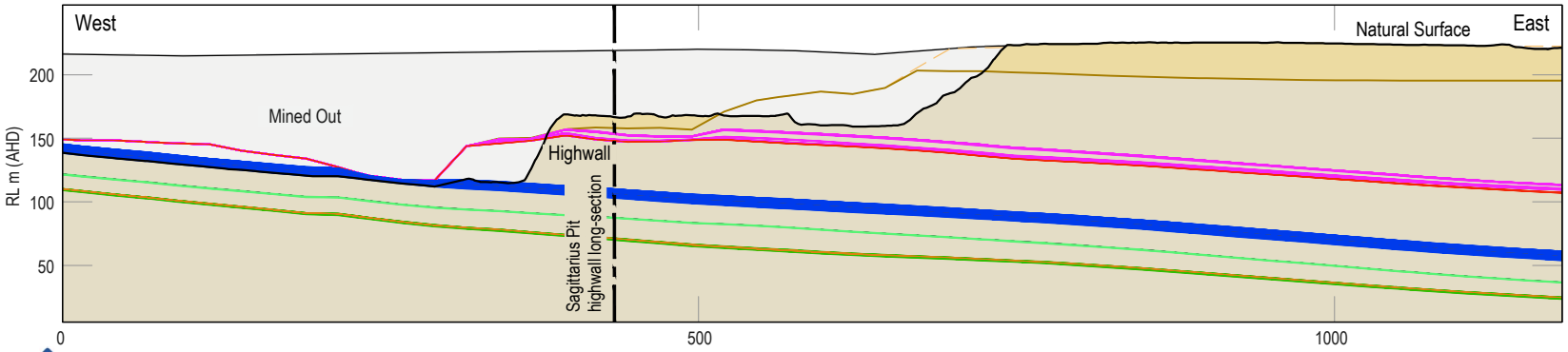
CROSS-SECTION | Bonnie Doon Pit
Viewed Looking North



CROSS-SECTION | Mimosa Pit
Viewed Looking North



CROSS-SECTION | Sagittarius Pit
Viewed Looking North



Legend

- Natural Surface
- Base of Tertiary
- Base of Weathering
- Current Pit Shell

Coal Seams

- T Seam Group
- MR Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- Yarabee Tuff
- PS Seam Group

Horizontal Scale
(V/H = 1)

0 100 200m

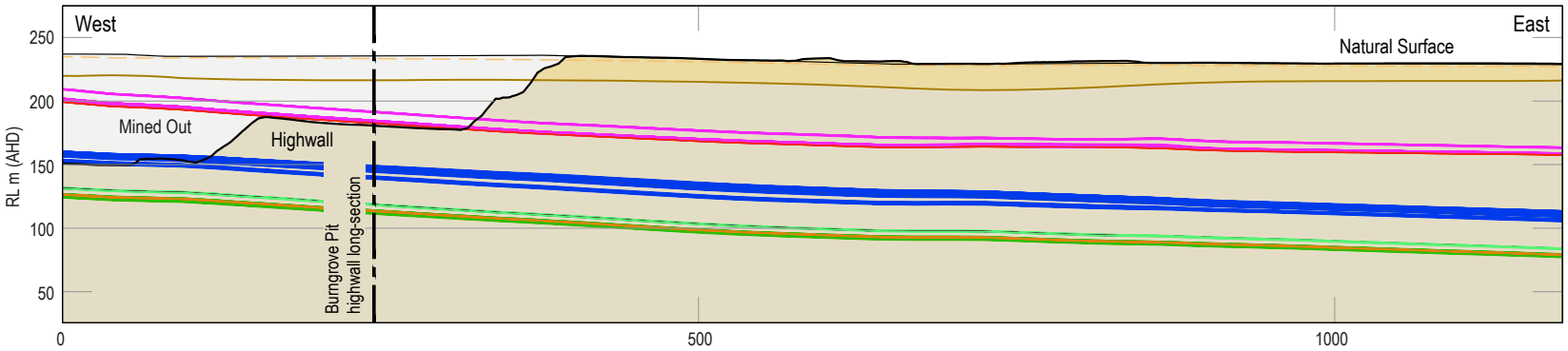
WHITEHAVEN

Minserve CAD File: Bhpb008m07.dwg

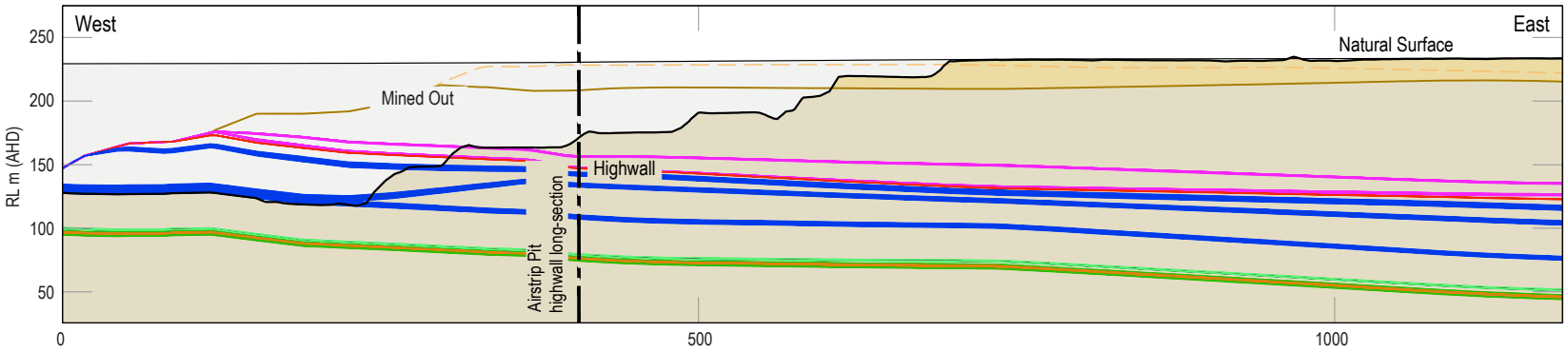
Pit cross-sections

Figure **A8**

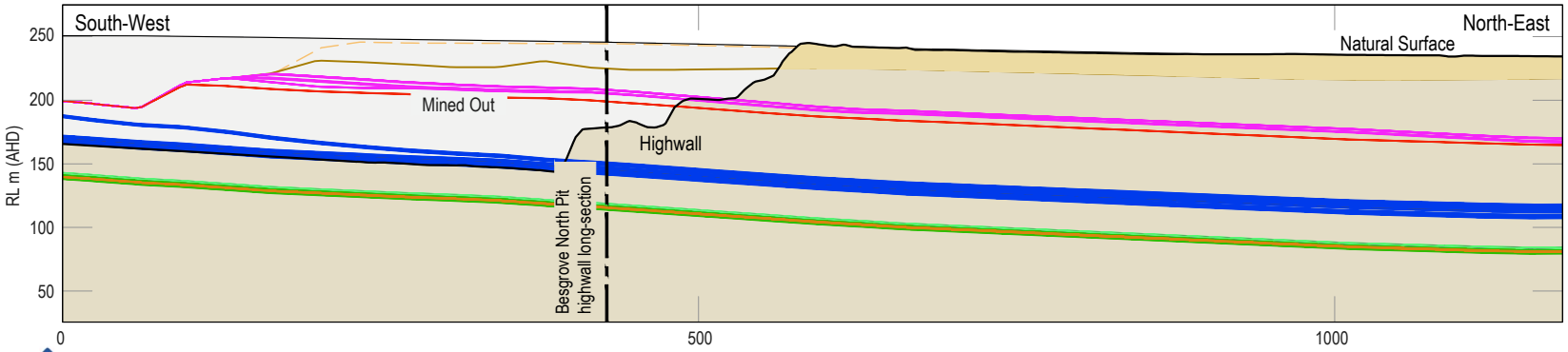
CROSS-SECTION | Burngrove Pit
Viewed Looking North



CROSS-SECTION | Airstrip Pit
Viewed Looking North



CROSS-SECTION | Besgrove North Pit
Viewed Looking North West



Legend

- Natural Surface
- Base of Tertiary
- Base of Weathering
- Current Pit Shell

Coal Seams

- T Seam Group
- MR Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- Yarabee Tuff
- PS Seam Group

Horizontal Scale
(V/H = 1)

0 100 200m

WHITEHAVEN

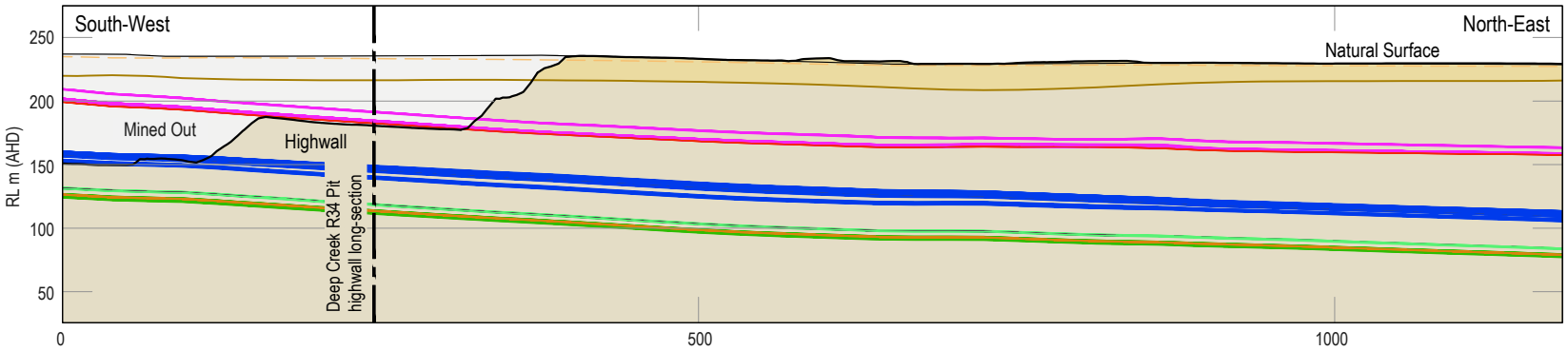
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Pit cross-sections

Figure **A9**

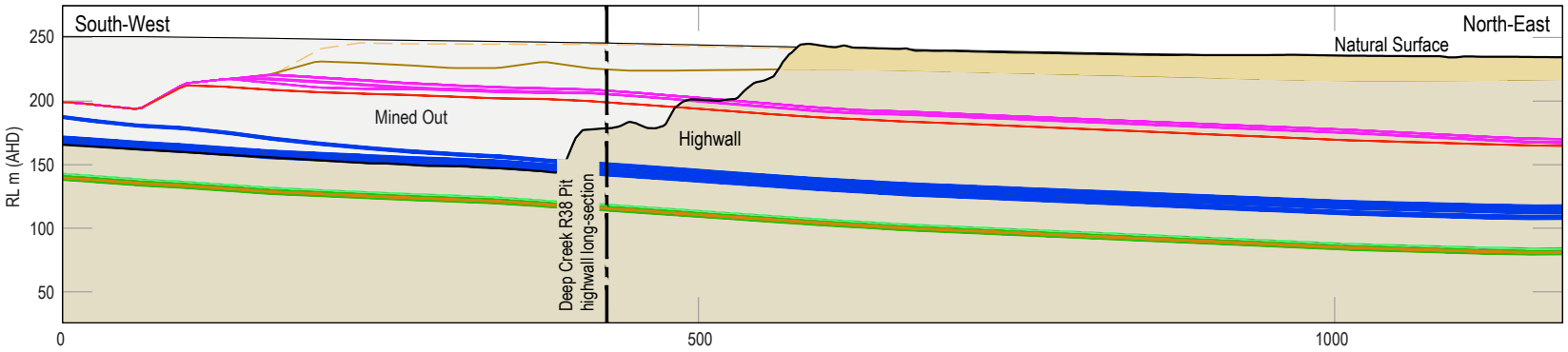
CROSS-SECTION | Deep Creek R34 Pit

Viewed Looking North



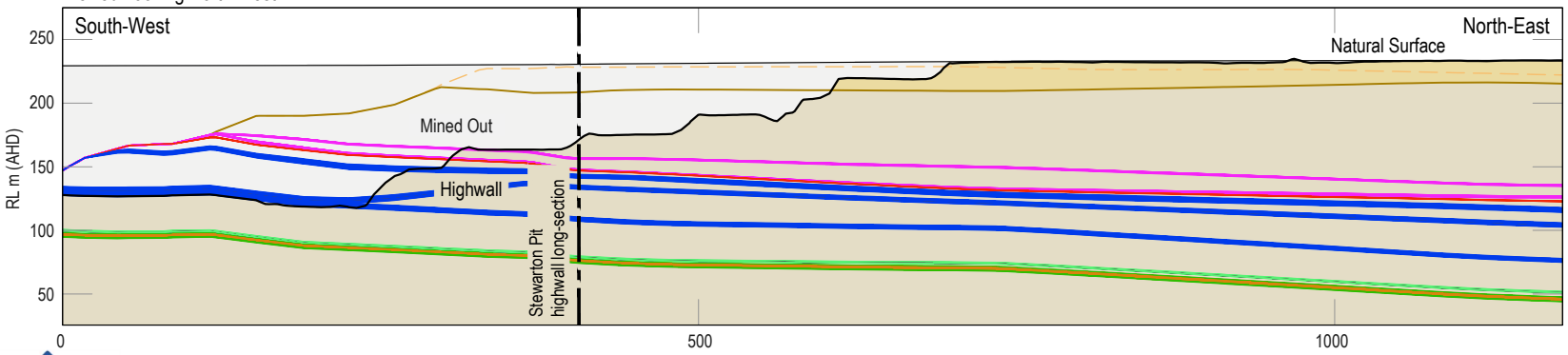
CROSS-SECTION | Deep Creek R38 Pit

Viewed Looking North



CROSS-SECTION | Stewarton North Pit

Viewed Looking North West



Legend

- Natural Surface
- Base of Tertiary
- Base of Weathering
- Current Pit Shell

Coal Seams

- T Seam Group
- MR Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- Yarabee Tuff
- PS Seam Group

Horizontal Scale

(V/H = 1)

0 100 200m

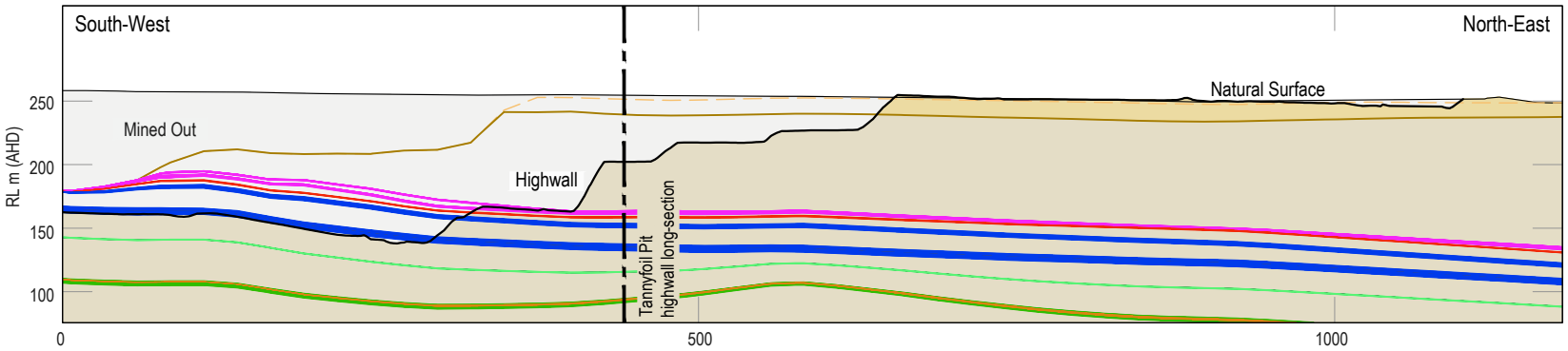
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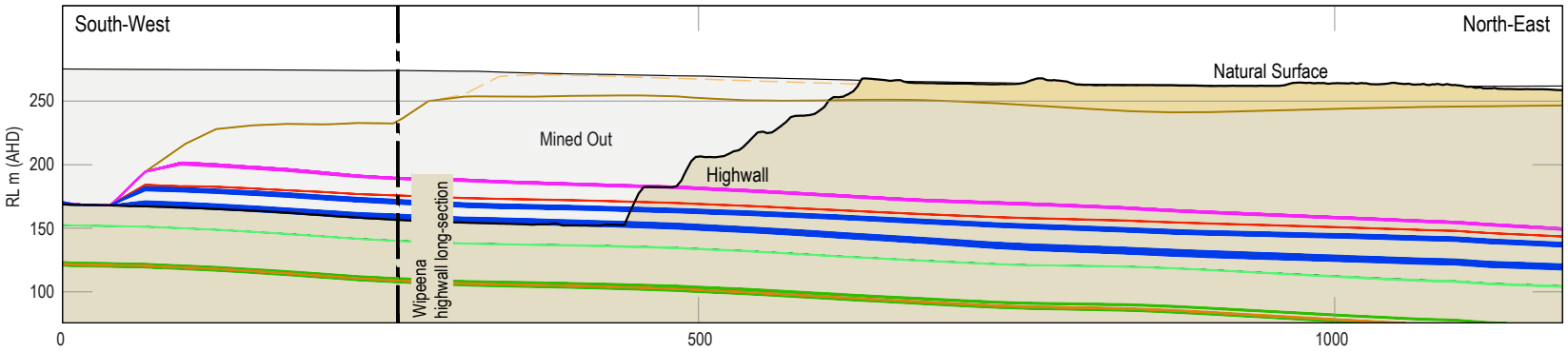
Pit cross-sections

Figure **A10**

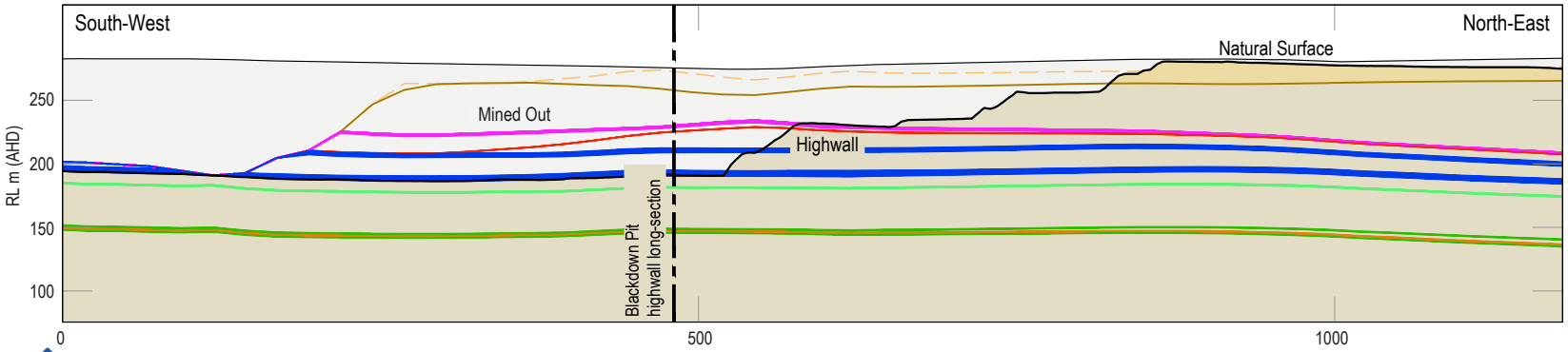
CROSS-SECTION | Tannyfoil Pit
Viewed Looking North



CROSS-SECTION | Wilpeena Pit
Viewed Looking North



CROSS-SECTION | Blackdown Pit
Viewed Looking North West



Legend

- Natural Surface
- Base of Tertiary
- Base of Weathering
- Current Pit Shell

Coal Seams

- T Seam Group
- MR Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- Yarabee Tuff
- PS Seam Group

Horizontal Scale
(V/H = 1)

0 100 200m

WHITEHAVEN

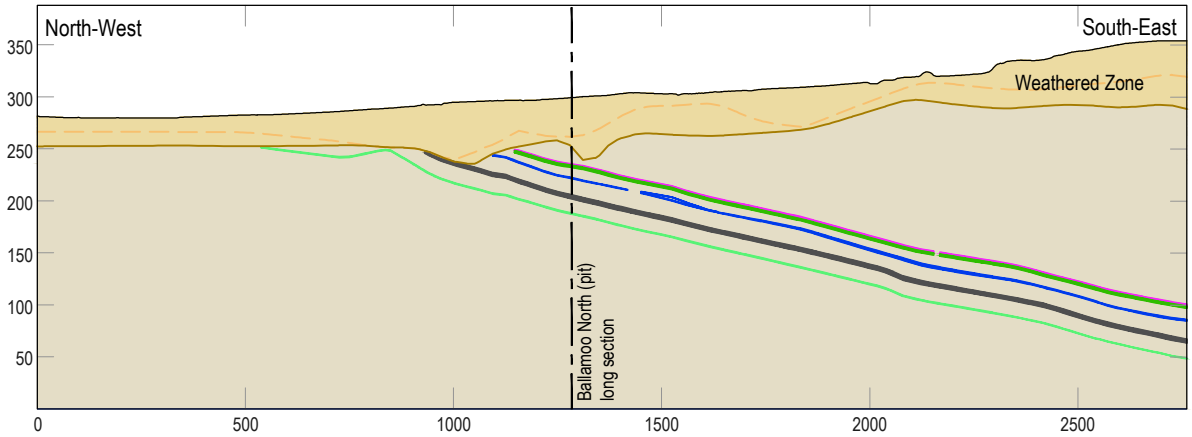
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Pit cross-sections

Figure **A11**

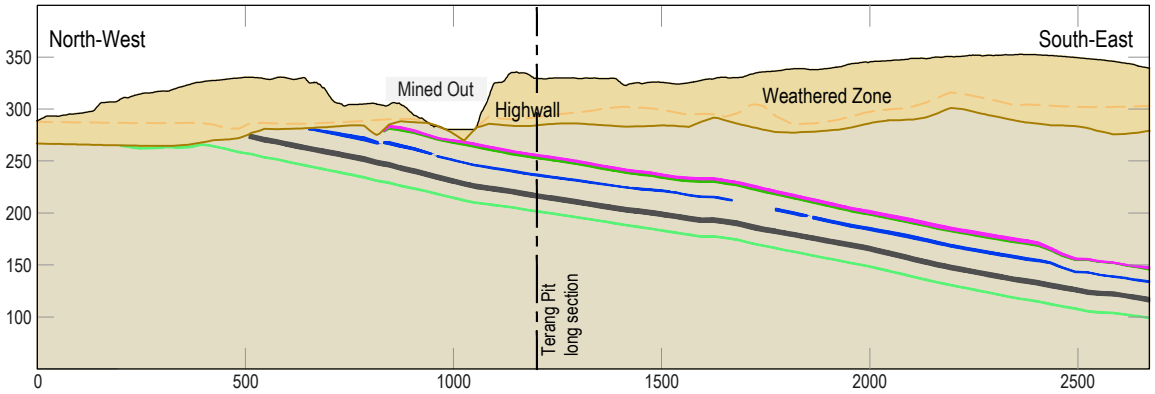
CROSS-SECTION | Ballamoo North

Viewed Looking North-East (Vertical Exaggeration x2.5)



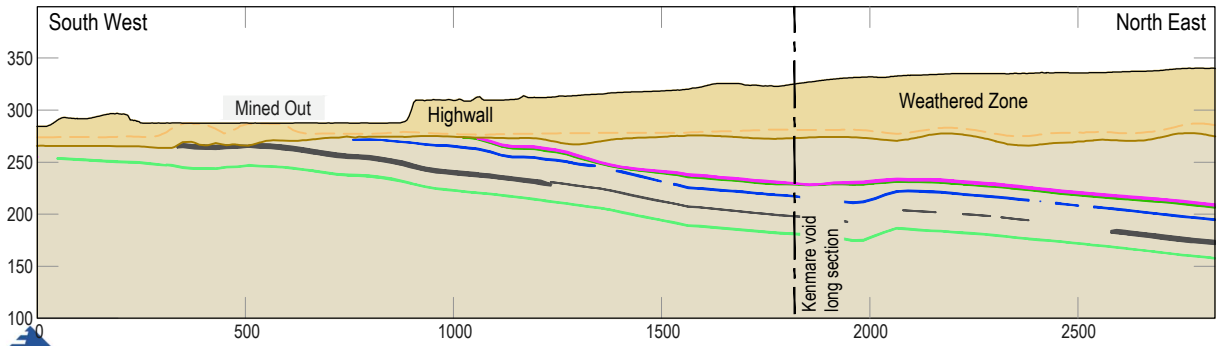
CROSS-SECTION | Terang Pit

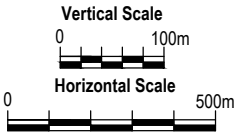
Viewed Looking North-East (Vertical Exaggeration x2.5)



CROSS-SECTION | Kenmare Pit

Viewed Looking North-West (Vertical Exaggeration x2.5)





Legend

- Natural Surface
- Base of Tertiary
- Base of Weathering

Coal Seams

- T Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- PS Seam Group

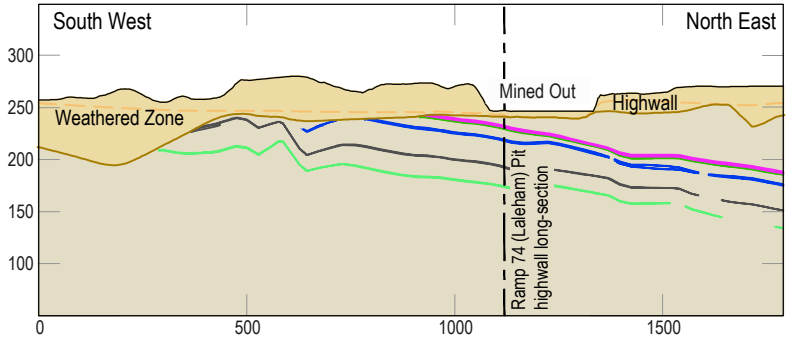
WHITEHAVEN

Minserve CAD File: Bhpb008m11-South.dwg

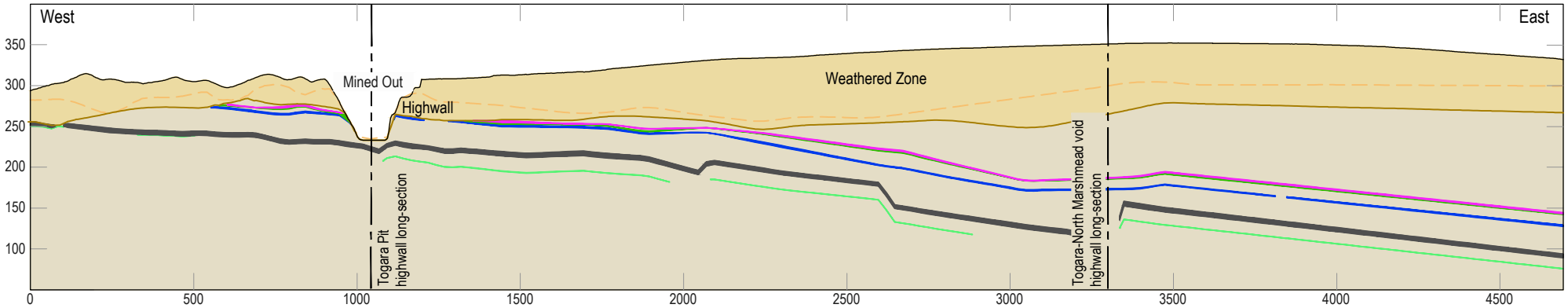
Pit cross-sections

Figure **A12**

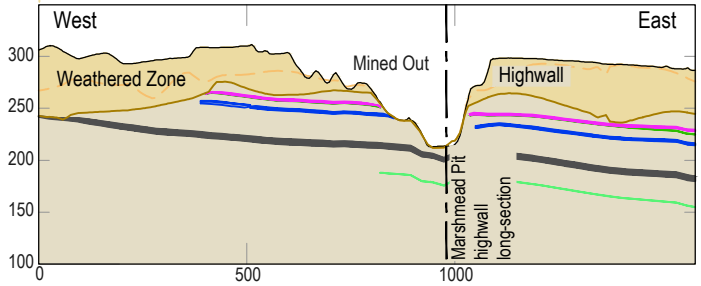
CROSS-SECTION | Ramp 74 (Laleham) Pit
Viewed Looking North-West (Vertical Exaggeration x2.5)



CROSS-SECTION | Togara Pit and Proposed Togara-North Marshmead Pit
Viewed Looking North (Vertical Exaggeration x2.5)



CROSS-SECTION | Marshmead Pit
Viewed Looking North-West (Vertical Exaggeration x2.5)



Legend
- Natural Surface
- Base of Tertiary
- Base of Weathering

Coal Seams
- T Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- PS Seam Group

Vertical Scale
0 — 100m

Horizontal Scale
0 — 500m

WHITEHAVEN

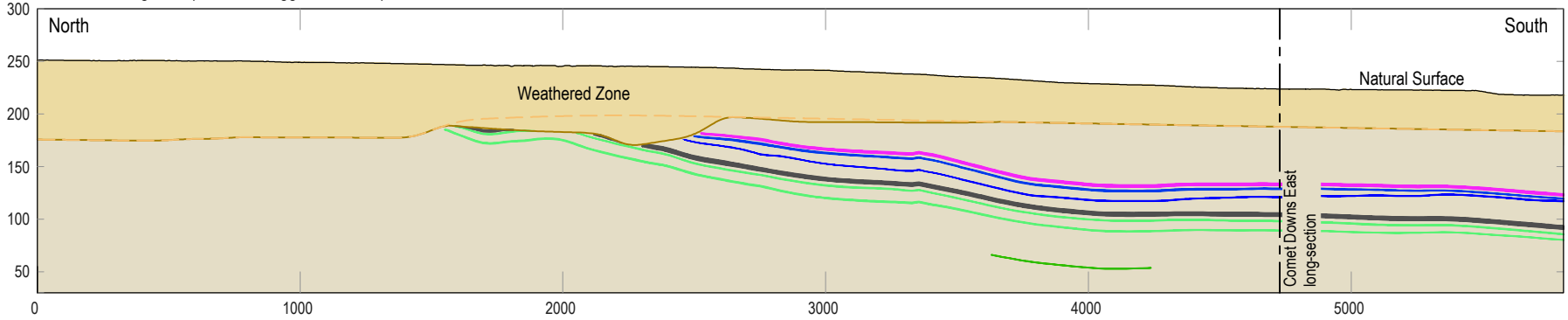
Minserve CAD File: Bhpb008m11 Blackwater - South.dwg

Pit cross-sections

Figure **A13**

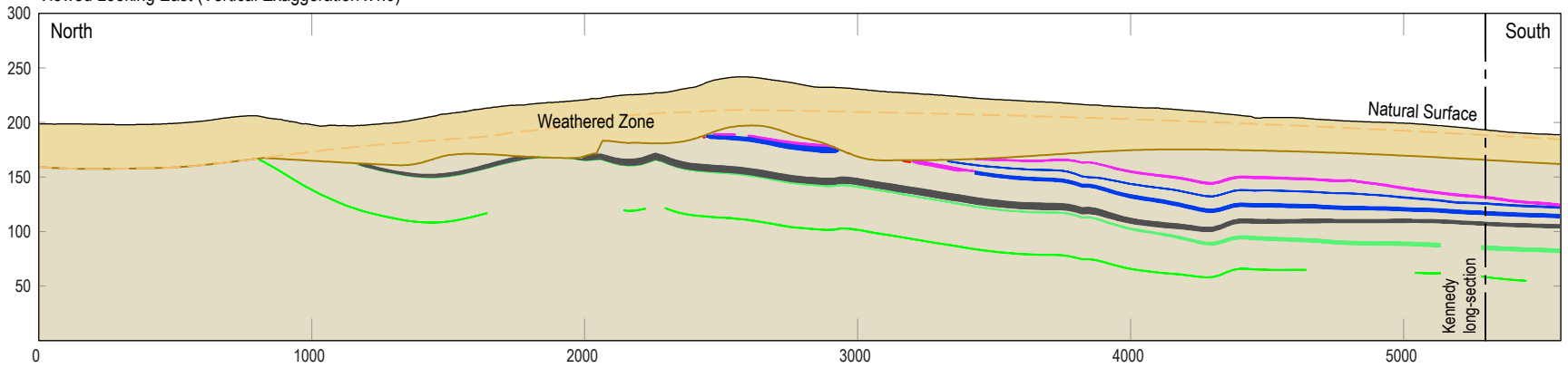
CROSS-SECTION | Comet Downs East Proposed Pit

Viewed Looking East (Vertical Exaggeration x4.0)



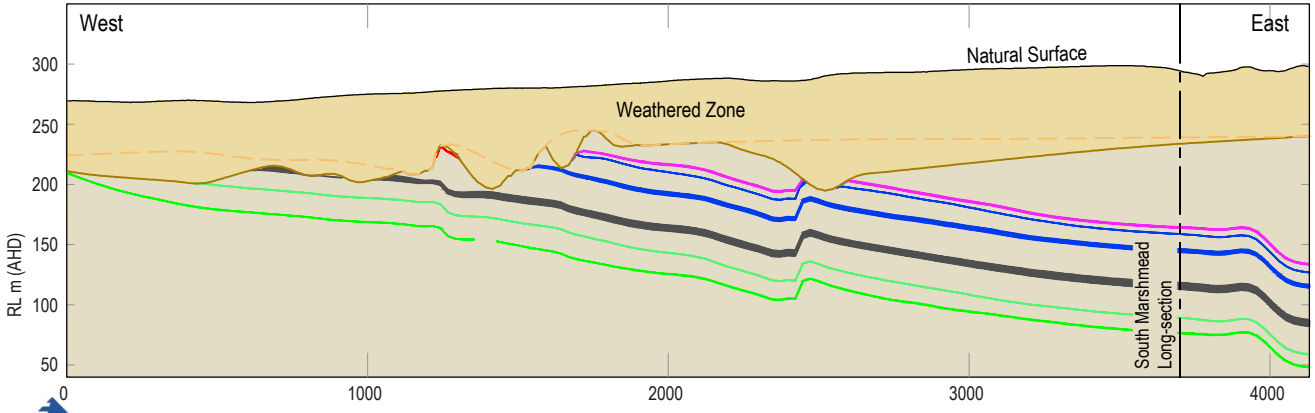
CROSS-SECTION | Kennedy Proposed Pit

Viewed Looking East (Vertical Exaggeration x4.0)



CROSS-SECTION | South Marshmead Proposed Pit

Viewed Looking North (Vertical Exaggeration x4.0)



Legend

- Natural Surface
- Base of Tertiary
- Base of Weathering

Coal Seams

- T Seam Group
- P & L Seam Group
- LR Seam Group
- SG Seam Group
- PS Seam Group

Vertical Scale

0 — 100m

Horizontal Scale

0 — 500m

WHITEHAVEN

Minserve CAD File: Bhpb008m12-MDL Areas.dwg

Pit cross-sections

Figure **A14**

Appendix B – AMD Hazard Scoring Tables

AMD hazard and likelihood of AMD generation from spoil landforms

- Table B1 Ramp 8 final landform
- Table B2 Bonnie Doon final landform
- Table B3 Mimosa-Besgrove final landform
- Table B4 Deep Creek final landform
- Table B5 Stewarton final landform
- Table B6 Tannyfoil final landform
- Table B7 Blackdown final landform
- Table B8 South Ballamoo (Terang) final landform
- Table B9 Kenmare final landform
- Table B10 Ramp 74 final landform
- Table B11 Togara-North Marshmead final landform
- Table B12 South Marshmead final landform
- Table B13 Kennedy final landform
- Table B14 Comet Downs East final landform

AMD hazard and likelihood of AMD generation from TSF landforms

- Table B15 NCPP TSF landform
- Table B16 Laleham TSF landform
- Table B17 Bottom Dam TSF (and rejects) landform

AMD hazard and likelihood of AMD generation from rejects landform

- Table B18 Ramp 36 rejects landform

AMD hazard and likelihood of AMD generation from residual voids

- Table B19 Ramp 8 residual void walls and floor
- Table B20 Bonnie Doon residual void walls and floor
- Table B21 Mimosa-Besgrove and Ramp 30S residual void walls and floor
- Table B22 Deep Creek and Stewarton North residual void walls and floor
- Table B23 Stewarton South , Tannyfoil and South Ballamoo residual void walls and floor
- Table B24 Kenmare residual void walls and floor
- Table B25 Ramp 74 residual void walls and floor
- Table B26 Togara-North Marshmead residual void walls and floor
- Table B27 South Marshmead residual void walls and floor
- Table B28 Kennedy residual void walls and floor
- Table B29 Comet Downs East residual void walls and floor

Table B1. AMD hazard scoring for source materials and likelihood for AMD generation from Ramp 8 final landform

Ramp 8: Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from Ramp 8 spoil landform
Non-carbonaceous spoil Distributed throughout	96%	1.4%	1.4%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**3.5** Low	General spoil, which comprises all of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are mostly associated with seams and, as such, most PAF 'spoil' material is associated with seams - as parting or within 1.5m (typically) above and below seams and, as such, (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Ramp 8 landform contains no rejects or tailings. Overall, about 2% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 418 µS/cm. The hazard for AMD generation from Ramp 8 spoil landform is considered to be **LOW**. The likelihood for AMD generation from Ramp 8 spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	4.0%	14%	0.5%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 4% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects No current or future rejects disposed into Ramp 8 landform.	0%	27%	0%	No current or future rejects located within Ramp 8 landform.	**n/a**	**n/a**	**n/a**	**n/a**		
Tailings No current or future tailings disposed into Ramp 8 landform.	0%	48%	0%	No current or future tailings located within Ramp 8 landform.	**n/a**	**n/a**	**n/a**	**n/a**		

Table B2. AMD hazard scoring for source materials and likelihood for AMD generation from Bonnie Doon final landform

Bonnie Doon: Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from Bonnie Doon spoil landform
Non-carbonaceous spoil Distributed throughout	96%	1.4%	1.4%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**3.5** Low	General spoil, which comprises all of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are mostly associated with seams and, as such, most PAF 'spoil' material is associated with seams - as parting or within 1.5m (typically) above and below seams and, as such, (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Bonnie Doon landform contains no rejects or tailings. Overall, about 2% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 418 µS/cm. The hazard for AMD generation from Bonnie Doon spoil landform is considered to be **LOW**. The likelihood for AMD generation from Bonnie Doon spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	4.0%	14%	0.5%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 4% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects No / negligible current or future rejects disposed into Bonnie Doon landform.	0%	27%	0%	No (or negligible) current or future rejects located within Bonnie Doon landform.	**n/a**	**n/a**	**n/a**	**n/a**		
Tailings No current or future tailings disposed into Bonnie Doon landform	0%	48%	0%	No current or future tailings located within Bonnie Doon landform. (excludes tailings disposed into Bonnie Doon pit/void)	**n/a**	**n/a**	**n/a**	**n/a**		

Table B3. AMD hazard scoring for source materials and likelihood for AMD generation from Mimosa-Besgrove final landform

Mimosa-Besgrove: Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from Mimosa-Besgrove spoil landform
Non-carbonaceous spoil Distributed throughout	95%	1.4%	1.3%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 95% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**2.9** Low	General spoil, which comprises approximately 98% of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are associated with seams and, as such, most PAF spoil material is associated with seams - as parting or within 1.5m (typically) above and below seams. As such (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Overall, about 2.3% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is mostly widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. Rejects - located within the pit shell at Ramp 32 rejects dump and throughout spoil between Ramps 22 to 26 - comprise a very small proportion of the landform (approximately 2%), however, approximately 27% of rejects samples have been conservatively classified as 'PAF' of some type and are assessed as posing a moderate AMD source hazard. Current and future rejects are disposed broadly within/amongst spoil and will be buried by overwhemingly NAF spoil. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 436 µS/cm. The hazard for AMD generation from Mimosa-Besgrove spoil landform is considered to be **LOW**. The likelihood for AMD generation from Mimosa-Besgrove spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	2.9%	14%	0.4%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 3% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects Concentrated within the spoil dump area at Ramp 32 rejects dump; and broadly distributed between Ramps 22 to 26. Future rejects assumed to be broadly distributed throughout landform.	1.9%	27%	0.5%	Up to 27% of rejects (originating from NCPP) are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 1.38% ('PAF' samples). NAF samples have a 75th percentile S value of 0.65%. 75th percentile EC of rejects = 1390 µS/cm. Rejects comprise a very small proportion of mineral waste in the landform - approximately 2%. Approximately half of the current rejects are concentrated at Deep Creek (Ramp 32) rejects dump - the remaining half are disposed broadly within/amongst predominantly non-carbonaceous spoil. Future rejects will be broadly disposed amongst spoil.	**5** Plausible	**7** Moderate-High	**7** Moderate-High	**12** Moderate		
Tailings No current or future tailings disposed into Mimosa-Besgrove landform	0%	48%	0%	No current or future tailings located within Mimosa-Besgrove landform.	**n/a**	**n/a**	**n/a**	**n/a**		

Table B4. AMD hazard scoring for source materials and likelihood for AMD generation from Deep Creek final landform

Deep Creek: Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from Deep Creek spoil landform
Non-carbonaceous spoil Distributed throughout	96%	1.4%	1.4%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**3.4** Low	General spoil, which comprises approximately 99% of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are associated with seams and, as such, most PAF spoil material is associated with seams - as parting or within 1.5m (typically) above and below seams. As such (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Overall, about 2% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. Current rejects are broadly distributed throughout spoil, and future rejects are expected to have similar broad distribution. Rejects comprise a very small proportion of the landform (<1%), however, approximately 27% of rejects samples have been conservatively classified as 'PAF' of some type and are assessed as posing a moderate AMD source hazard. Current and future rejects are disposed broadly within/amongst spoil and will be buried by overwhemingly NAF spoil. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 426 µS/cm. The hazard for AMD generation from Deep Creek spoil landform is considered to be **LOW**. The likelihood for AMD generation from Deep Creek spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	3.0%	14%	0.4%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 3% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects Currently located broadly within the spoil dump area. Future rejects assumed to be broadly distributed throughout Deep Creek landform.	0.8%	27%	0.2%	Up to 27% of rejects (originating from NCPP) are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 1.38% (PAF sampes). NAF samples have a 75th percentile S value of 0.65%. 75th percentile EC of rejects = 1390 µS/cm. Rejects comprise a very small proportion of mineral waste in the landform - less than 1% - and are disposed within/amongst predominantly non-carbonaceous spoil. The final spoil landform will essentially be comprised of (mostly non-carbonaceous) spoil.	**5** Plausible	**7** Moderate-High	**7** Moderate-High	**12** Moderate		
Tailings No current or future tailings disposed into Deep Creek landform	0%	48%	0%	No current or future tailings located within Deep Creek landform.	**n/a**	**n/a**	**n/a**	**n/a**		

Table B5. AMD hazard scoring for source materials and likelihood for AMD generation from Stewarton final landform

Stewarton: Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from Stewarton spoil landform
Non-carbonaceous spoil Distributed throughout	96%	1.4%	1.4%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**3.4** Low	General spoil, which comprises essentially all of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are associated with seams and, as such, most PAF spoil material is associated with seams - as parting or within 1.5m (typically) above and below seams. As such (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Overall, about 2% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is mostly widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. No current rejects within the spoil dump. Future rejects are expected to comprise a very small proportion of the landform (up to 0.2%), however, approximately 27% of rejects samples have been conservatively classified as 'PAF' of some type and are assessed as posing a moderate AMD source hazard. Future rejects will be disposed broadly within/amongst spoil and will be buried by overwhemingly NAF spoil. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 420 µS/cm. The hazard for AMD generation from Stewarton spoil landform is considered to be **LOW**. The likelihood for AMD generation from Stewarton spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	4.0%	14%	0.5%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 4% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects No rejects currently in Stewarton landform. Future rejects broadly disposed into Stewarton landform	0.2%	27%	0.06%	Up to 27% of rejects (originating from NCPP) are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 1.38% (PAF sampes). NAF samples have a 75th percentile S value of 0.65%. 75th percentile EC of rejects = 1390 µS/cm. Future rejects are estimated to comprise a very small proportion of mineral waste in the landform (up to 0.2%) - and are disposed within/amongst predominantly non-carbonaceous spoil. The final spoil landform will essentially be comprised of (mostly non-carbonaceous) spoil.	**5** Plausible	**7** Moderate-High	**7** Moderate-High	**12** Moderate		
Tailings No current or future tailings disposed into Stewarton landform	0%	48%	0%	No current or future tailings located within Stewarton landform.	**n/a**	**n/a**	**n/a**	**n/a**		

Table B6. AMD hazard scoring for source materials and likelihood for AMD generation from Tannyfoil final landform

Tannyfoil: Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from Tannyfoil spoil landform
Non-carbonaceous spoil Distributed throughout	96%	1.4%	1.4%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**3.5** Low	General spoil, which comprises all of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are mostly associated with seams and, as such, most PAF 'spoil' material is associated with seams - as parting or within 1.5m (typically) above and below seams and, as such, (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Tannyfoil landform contains no rejects or tailings. Overall, about 2% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 418 µS/cm. The hazard for AMD generation from Tannyfoil spoil landform is considered to be **LOW**. The likelihood for AMD generation from Tannyfoil spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	4.0%	14%	0.5%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 4% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects No current or future rejects disposed into Tannyfoil landform	0%	27%	0%	No current or future rejects to be disposed into Tannyfoil landform	**n/a**	**n/a**	**n/a**	**n/a**		
Tailings No current or future tailings disposed into Tannyfoil landform	0%	48%	0%	No current or future tailings located within Tannyfoil landform.	**n/a**	**n/a**	**n/a**	**n/a**		

Table B7. AMD hazard scoring for source materials and likelihood for AMD generation from Blackdown final landform

Blackdown: Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from Blackdown spoil landform
Non-carbonaceous spoil Distributed throughout	96%	1.4%	1.4%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**3.5** Low	General spoil, which comprises all of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are mostly associated with seams and, as such, most PAF 'spoil' material is associated with seams - as parting or within 1.5m (typically) above and below seams and, as such, (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Blackdown landform contains no rejects or tailings. Overall, about 2% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 418 µS/cm. The hazard for AMD generation from Blackdown spoil landform is considered to be **LOW**. The likelihood for AMD generation from Blackdown spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	4.0%	14%	0.5%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 4% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects No current or future rejects disposed into Blackdown landform	0%	27%	0%	No current or future rejects located within Blackdown landform.	**n/a**	**n/a**	**n/a**	**n/a**		
Tailings No current or future tailings disposed into Blackdown landform	0%	48%	0%	No current or future tailings located within Blackdown landform.	**n/a**	**n/a**	**n/a**	**n/a**		

Table B8. AMD hazard scoring for source materials and likelihood for AMD generation from South Ballamoo (Terang) final landform

South Ballamoo (Terang): Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from South Ballamoo (Terang) spoil landform
Non-carbonaceous spoil Distributed throughout	95%	1.4%	1.3%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**2.7** Low	General spoil, which comprises essentially all of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are associated with seams and, as such, most PAF spoil material is associated with seams - as parting or within 1.5m (typically) above and below seams. As such (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Overall, about 2.5% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is mostly widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. Rejects - currently located at Ramp 64 rejects dump within the pit shell - comprise a very small proportion of the landform (less than 1%), however, approximately 71% of rejects (from SCPP) have been conservatively classified as 'PAF' of some type and are assessed as posing a moderate AMD source hazard. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 426 µS/cm. The hazard for AMD generation from South Ballamoo spoil landform is considered to be **LOW**. The likelihood for AMD generation from South Ballamoo spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	4.0%	14%	0.5%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 4% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects Currently located at Ramp 64 (northern end of existing Terang pit [South Ballamoo pit]). No future rejects disposed into this landform	0.8%	71%	0.6%	Up to 71% of rejects (originating from the SCPP) are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 1.17% (PAF sampes). NAF samples have a 75th percentile S value of 0.10%. 75th percentile EC of rejects = 1410 µS/cm. Rejects, despite being prodominantly classified as 'PAF', comprise a very small proportion of mineral waste in the landform - less than 1% - and are disposed within/amongst predominantly non-carbonaceous spoil. The final spoil landform will essentially be comprised of (mostly non-carbonaceous) spoil.	**7** Expected	**7** Moderate-High	**7** Moderate-High	**14** Moderate		
Tailings No current or future tailings disposed into South Ballamoo landform	0%	72%	0%	No current or future tailings located within South Ballamoo landform.	**n/a**	**n/a**	**n/a**	**n/a**		

Table B9. AMD hazard scoring for source materials and likelihood for AMD generation from Kenmare final landform

Kenmare: Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from Kenmare spoil landform
Non-carbonaceous spoil Distributed throughout	95%	1.4%	1.3%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**2.3** Low	General spoil, which comprises approximately 98% of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are associated with seams and, as such, most PAF spoil material is associated with seams - as parting or within 1.5m (typically) above and below seams. As such (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Overall, less than 3.5% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, two-thirds of which is widely distributed throughout the bulk NAF spoil - and the remaining third as PAF rejects and tailings, which are concentrated at Ramp 72 (tailings) and at the southern end of the current Kenmare pit (rejects) and Ramp 70 (rejects). Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. Rejects located within the landform at Ramp 70; and rejects and tailings located within the landform in Kenmare pit (Ramp 72 pit) comprise a very small proportion of the landform (approximately 1% each for tailings and rejects). However, approximately 71% and 72% of rejects and tailings, respectively (and which originated from the SCPP), have been conservatively classified as 'PAF' of some type and are assessed as predominantly posing a high AMD source hazard. AMD (as AD) has been observed from Ramp 72 TSF and from rejects located in the southern end of Kenmare pit. No new (future) rejects or tailings are expected to be disposed into this landform. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 427 µS/cm. Overall, the hazard for AMD generation from Kenmare spoil landform is considered to be **LOW** and the likelihood for AMD generation from Kenmare spoil landform is rated **HIGHLY UNLIKELY.** However, the AMD source hazard for rejects located at Ramp 70 is **Moderate**; for buried rejects within the southern end of current Kenmare pit is **HIGH**; and for tailings within Ramp 72 TSF and the southern end of current Kenmare pit is **MODERATE-HIGH**. The likelihood for AMD generation from Ramp 70 rejects buried within the Kenmare spoil landform is **PROBABLE / LIKELY**, whereas the likelihood for AMD generation from buried rejects and tailings within Ramp 72 TSF and the southern end of current Kenmare pit is **LIKELY to HIGHLY LIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	2.9%	14%	0.4%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 3% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects Within the spoil dump at Ramp 70. No future rejects disposed into Kenmare landform.	0.5%	71%	0.3%	Up to 71% of rejects (originating from the SCPP) are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 1.17% ('PAF' samples). NAF samples have a 75th percentile S value of 0.10%. 75th percentile EC of rejects = 1410 µS/cm. Rejects comprise a small proportion of mineral waste in the landform - approximately 1%, of which over half is disposed as mixed fine- and coarse rejects within the southern end of Kenmare pit (R72 pit). The spoil landform will predominantly be comprised of (mostly non-carbonaceous) spoil. AMD as AD has been observed from rejects in Kenmare pit.	**7** Expected	**7** Moderate-High	**7** Moderate-High	**14** Moderate		
Rejects Southern end of Kenmare pit. No future rejects disposed into Kenmare landform.	0.5%		0.3%		**15** Certain	**7** Moderate-High	**7** Moderate-High	**22** High		
Tailings Ramp 72 TSF at base of landform. No future tailings disposed into Kenmare landform.	1.2%	72%	0.8%	72% of tailings (originating from SCPP) are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. Tailings comprise a very small proportion of the overall spoil landform (approx. 1.2%) - however are concentrated in one area (Ramp 72 TSF). 75th percentile EC of tailings = 960 µS/cm. AMD capacity is based on a 75th percentile S value of 0.70%. Some tailings samples will generate AD. AMD quantity assumes proportion of PAF tailings samples approximates the proportion of tailings that are PAF. Tailings (TSF) will be buried by predominantly non-carbonaceous and NAF spoil. AMD as AD has been observed from Ramp 72 TSF.	**15** Certain	**5** Moderate	**3** Low-Moderate	**19** Moderate-High		

Table B10. AMD hazard scoring for source materials and likelihood for AMD generation from Ramp 74 final landform

Ramp 74 (Laleham): Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from Ramp 74 (Laleham) spoil landform
Non-carbonaceous spoil Distributed throughout	99%	1.4%	1.4%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**4.5** Low	General spoil, which comprises all of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are associated with seams and, as such, most PAF 'spoil' material is associated with seams - as parting or within 1.5m (typically) above and below seams and, as such, (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Ramp 74 landform contains no rejects or tailings. [Laleham TSF - located adjacent to the Ramp 74 spoil landform - is assessed as a 'stand alone' TSF landform.] Overall, about 1.5% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises only a small proportion of the landform. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 418 µS/cm. The hazard for AMD generation from Ramp 74 spoil landform is considered to be **LOW**. The likelihood for AMD generation from Ramp 74 spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	1.0%	14%	0.1%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 1% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects No current or future rejects disposed into Laleham landform.	0%	71%	0%	No current or future rejects located within Ramp 74 landform. Laleham TSF is assessed as a 'stand alone' TSF landform - refer to the AMD hazard assessment of Laleham TSF landform.	**n/a**	**n/a**	**n/a**	**n/a**		
Tailings No current or future tailings disposed into Laleham landform.	0%	72%	0%	No current or future tailings located within Ramp 74 landform. Laleham TSF is assessed as a 'stand alone' TSF landform - refer to the AMD hazard assessment of Laleham TSF landform.	**n/a**	**n/a**	**n/a**	**n/a**		

Table B11. AMD hazard scoring for source materials and likelihood for AMD generation from Togara-North Marshmead final landform

Togara-North Marshmead: Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from Togara-North Marshmead spoil landform
Non-carbonaceous spoil Distributed throughout	94%	1.4%	1.3%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**2.9** Low	General spoil, which comprises essentially all of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are associated with seams and, as such, most PAF spoil material is associated with seams - as parting or within 1.5m (typically) above and below seams. As such (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Overall, less than 2.5% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is mostly widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. Rejects - currently located within the landform at Ramps 76 and 84 - comprise a very small proportion of the landform (approximately 0.2%), however, approximately 71% of the rejects (originating from the SCPP) have been conservatively classified as 'PAF' of some type and are assessed as posing a moderate AMD source hazard. No new (future) rejects are expected to be disposed into this landform. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 419 µS/cm. The hazard for AMD generation from Togara-North Marshmead spoil landform is considered to be **LOW**. The likelihood for AMD generation from Togara-North Marshmead spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	6.0%	14%	0.8%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 6% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects Currently located within the spoil dump area at Ramp 76 and Ramp 84. No future rejects disposed into Togara-North Marshmead landform.	0.2%	71%	0.1%	Up to 71% of rejects (originating from the SCPP) are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 1.17% (PAF sampes). NAF samples have a 75th percentile S value of 0.10%. 75th percentile EC of rejects = 1410 µS/cm. Rejects, despite being prodominantly classified as 'PAF', comprise a very small proportion of mineral waste in the landform - approximately 0.2% - and are disposed within/amongst predominantly non-carbonaceous spoil. The final spoil landform will essentially be comprised of (mostly non-carbonaceous) spoil.	**7** Expected	**7** Moderate-High	**7** Moderate-High	**14** Moderate		
Tailings No current or future tailings disposed into Togara-North Marshmead landform	0%	72%	0%	No current or future tailings located within Togara-North Marshmead landform.	**n/a**	**n/a**	**n/a**	**n/a**		

Table B12. AMD hazard scoring for source materials and likelihood for AMD generation from South Marshmead final landform

South Marshmead: Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from South Marshmead spoil landform
Non-carbonaceous spoil Distributed throughout	98%	1.4%	1.4%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**4.1** Low	General spoil, which comprises all of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are associated with seams and, as such, most PAF 'spoil' material is associated with seams - as parting or within 1.5m (typically) above and below seams and, as such, (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. South Marshmead landform contains no rejects or tailings. Overall, less than 2% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 418 µS/cm. The hazard for AMD generation from South Marshmead spoil landform is considered to be **LOW**. The likelihood for AMD generation from South Marshmead spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	2.0%	14%	0.3%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 2% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects South Marshmead is a proposed landform (currently doesn't exist). No future rejects disposed into South Marshmead landform.	0%	71%	0%	No current or future rejects located within South Marshmead landform.	**n/a**	**n/a**	**n/a**	**n/a**		
Tailings South Marshmead is a proposed landform (currently doesn't exist). No future tailings disposed into South Marshmead landform.	0%	72%	0%	No current or future tailings located within South Marshmead landform.	**n/a**	**n/a**	**n/a**	**n/a**		

Table B13. AMD hazard scoring for source materials and likelihood for AMD generation from Kennedy final landform

Kennedy: Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from Kennedy spoil landform
Non-carbonaceous spoil Distributed throughout	94%	1.4%	1.3%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**3.1** Low	General spoil, which comprises all of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are associated with seams and, as such, most PAF 'spoil' material is associated with seams - as parting or within 1.5m (typically) above and below seams and, as such, (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Kennedy landform contains no rejects or tailings. Overall, less than 2.5% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 418 µS/cm. The hazard for AMD generation from Kennedy spoil landform is considered to be **LOW**. The likelihood for AMD generation from Kennedy spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	6.0%	14%	0.8%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 6% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects Kennedy is a proposed landform (currently doesn't exist). No future rejects disposed into Kennedy landform.	0%	71%	0%	No current or future rejects located within Kennedy landform.	**n/a**	**n/a**	**n/a**	**n/a**		
Tailings Kennedy is a proposed landform (currently doesn't exist). No future tailings disposed into Kennedy landform.	0%	72%	0%	No current or future tailings located within Kennedy landform.	**n/a**	**n/a**	**n/a**	**n/a**		

Table B14. AMD hazard scoring for source materials and likelihood for AMD generation from Comet Downs East final landform

Comet Downs East: Landform components	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD hazard score	Landform AMD hazard score	Likelihood for AMD generation from Comet Downs East spoil landform
Non-carbonaceous spoil Distributed throughout	93%	1.4%	1.3%	Total S is low (75th percentile = 0.04%). NAF samples have a 75th percentile total S value of 0.04%. 'PAF' samples, which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S, have a 75th percentile total S value of 0.35% (and AMD capacity is based on this number). Less than 1.5% of non-carbonaceous spoil is conservatively classified as 'PAF'. 75th percentile EC of non-carbonaceous spoil = 418 µS/cm. Most of the PAF material is associated with seams - as parting or within 1.5m above and below seams. Non-carbonaceous spoil is estimated to comprise approximately 96% of mineral waste in the landform. ANC is largely available under field conditions.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low	**2.9** Low	General spoil, which comprises all of the landform, is overwhelmingly NAF with generally very low sulfur, excess neutralising capacity and low soluble metals concentration. Higher S materials are associated with seams and, as such, most PAF 'spoil' material is associated with seams - as parting or within 1.5m (typically) above and below seams and, as such, (and also due to seams being over-sampled) the percentage of 'PAF' spoil samples is not respresentative of the overall percentage of PAF in general spoil. Comet Downs East landform contains no rejects or tailings. Overall, less than 2.5% of the final landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material, which is widely distributed throughout the bulk NAF spoil. Non-carbonaceous and carbonaceous spoil are assigned low to low-moderate AMD capacity ratings based on the 75th percentile total S value for PAF samples, however PAF spoil comprises a very small proportion of the landform. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 418 µS/cm. The hazard for AMD generation from Comet Downs East spoil landform is considered to be **LOW**. The likelihood for AMD generation from Comet Downs East spoil landform is rated **HIGHLY UNLIKELY**.
Carbonaceous and/or coaly spoil Distributed throughout	7.0%	14%	1.0%	Up to 14% of carbonaceous spoil is conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. NAF samples have a 75th percentile total S value of 0.18%. 'PAF' samples have a 75th percentile total S value of 0.72% (and AMD capacity is based on this number). 75th percentile EC of carbonaceous spoil = 414 µS/cm. Carbonaceous spoil is estimated to comprise approximately 7% of mineral waste in the landform, and assumes all carbonaceous spoil is distributed amongst non-carbonaceous spoil. AMD quantity conservatively assumes proportion of PAF carbonaceous spoil samples approximates the proportion of carbonaceous spoil that is PAF.	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Rejects Comet Downs East is a proposed landform (currently doesn't exist). No future rejects disposed into Comet Downs East landform.	0%	71%	0%	No current or future rejects located within Comet Downs East landform.	**n/a**	**n/a**	**n/a**	**n/a**		
Tailings Comet Downs East is a proposed landform (currently doesn't exist). No future tailings disposed into Comet Downs East landform.	0%	72%	0%	No current or future tailings located within Comet Downs East landform.	**n/a**	**n/a**	**n/a**	**n/a**		

Table B15. AMD hazard scoring for source materials and likelihood for AMD generation from NCPP TSF landform (unrehabilitated)

NCPP TSF: Components (without cover)	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD source hazard score	Landform AMD hazard score (pre-rehabilitation)	Likelihood for AMD generation from NCPP TSF (before rehabilitation)
Tailings	80%	48%	38%	Based on data from 478 tailings samples from NCPP TSF and NCPP, up to 48% of tailings are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 2.16% ('PAF' samples). NAF samples have a 75th percentile S value of 0.69%. Conservatively assumes proportion of PAF tailings samples approximates the proportion of tailings in NCPP TSF that are PAF. Assumes equal distribution of PAF/NAF tailings throughout the TSF. AMD as AD has been observed from tailings at NCPP TSF.	**15** High	**10** High	**10** High	**25** High	**19** Moderate-High	The hazard for AMD generation in the landform is based on the large majority (approximately 80%) of the landform being tailings, of which 48% is conservatively estimated to be PAF (of some type). Of the 'PAF' samples, about 70% are UC(PAF) or PAF-LC and, as such, are considered to have a relatively moderate capacity to generate significant acidity. However, AMD is evident (as AD, with pH <4.5) in tailings samples located at the TSF and in seepage from the toe of the TSF. Overall, about 40% of the NCPP TSF landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material - most of which is tailings, which are assessed as posing a High AMD source hazard. Rejects are estimated to comprise about 19% of the TSF landform (almost entirely as embankment material) and are assessed as posing a low-moderate AMD source hazard. General fill (spoil) is assumed to comprise about 1% of the TSF and mostly located within embankments. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 961 µS/cm. The hazard for AMD generation from NCPP TSF landform is conservatively considered to be **MODERATE-HIGH**. The likelihood for AMD generation from NCPP TSF landform is conservatively rated as **HIGHLY LIKELY**, the highest likelihood category - noting that AMD has already been observed from this TSF.
Rejects Primarily located within embankments	19%	8%	1.4%	Based on data from 93 rejects samples from NCPP TSF and NCPP, up to 8% of rejects are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 0.65% (PAF samples). NAF samples have a 75th percentile S value of 0.50%. Conservatively assumes proportion of PAF rejects samples approximates the proportion of rejects in NCPP TSF that are PAF. Assumes equal distribution of PAF/NAF rejects throughout the areas of the TSF where rejects are located (primarily embankments).	**5** Plausible	**5** Moderate	**3** Low-Moderate	**9** Low-Moderate		
Fill / Spoil Fill (assumed spoil) within the TSF, including within embankments. Excludes existing spoil (if any) on the surface of the TSF.	1%	2%	0.0%	Proportion of fill in TSF is based on drillhole investigations. Based on data from all spoil samples - as a proxy for general fill commonly found in TSFs - up to 2% of fill is conservatively classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 0.52% ('PAF' samples). NAF samples have a 75th percentile S value of 0.04%. Conservatively assumes proportion of PAF spoil samples approximates the proportion of fill in the TSF that are PAF.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low		

Table B16. AMD hazard scoring for source materials and likelihood for AMD generation from Laleham TSF landform (unrehabilitated)

Laleham TSF: Components (without cover)	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD source hazard score	Landform AMD hazard score (pre-rehabilitation)	Likelihood for AMD generation from Laleham TSF (before rehabilitation)
Tailings	90%	84%	76%	Based on data from 95 tailings samples from Laleham TSF, up to 84% of tailings are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 0.72% ('PAF' samples). NAF samples have a 75th percentile S value of 0.17%. Conservatively assumes proportion of PAF tailings samples approximates the proportion of tailings in Laleham TSF that are PAF. Assumes equal distribution of PAF/NAF tailings throughout the TSF.	**15** High	**5** Moderate	**5** Moderate	**20** Moderate-High	**17** Moderate-High	The hazard for AMD generation in the landform is based on the majority (90%) of the landform being tailings of which 84% is conservatively estimated to be PAF. About 30% of tailings samples are displaying evidence of AD (pH <4.5), with associated evidence of sulfide oxidation (to sulfate) and consumption of ANC. Overall, about 79% of the Laleham TSF landform (excluding the existing spoil cover) is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material - most of which is tailings, which are assessed as posing a moderate-high AMD source hazard. Rejects are estimated to comprise about 4% of the TSF landform and are also assessed as posing a moderate AMD source hazard. Spoil/fill within the TSF is estimated to comprise about 6% of the landform (excluding the existing spoil cover) and is assessed as posing a low AMD source hazard. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 1139 µS/cm. The hazard for AMD generation from Laleham TSF landform is conservatively considered to be **MODERATE-HIGH**. The likelihood for AMD generation from Laleham TSF landform is conservatively rated as **PROBABLE / LIKELY**.
Rejects	4%	71%	2.9%	Only six rejects samples from Laleham TSF have geochemical data. Therefore, based on data from 161 aged rejects samples originating from SCPP, up to 71% of rejects are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 1.17% (PAF samples). NAF samples have a 75th percentile S value of 0.10%. Conservatively assumes proportion of PAF rejects samples approximates the proportion of rejects in Laleham TSF that are PAF. Assumes equal distribution of PAF/NAF rejects throughout the areas of the TSF where rejects are located.	**7** Expected	**7** Moderate-High	**7** Moderate-High	**14** Moderate		
Fill / Spoil Fill (assumed spoil) within the TSF, including within embankments. Excludes existing spoil (if any) on the surface of the TSF.	6%	2%	0.1%	Proportion of fill in TSF is based on drillhole investigations. Based on data from all spoil samples - as a proxy for general fill commonly found in TSFs - up to 2% of fill is conservatively classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 0.52% ('PAF' samples). NAF samples have a 75th percentile S value of 0.04%. Conservatively assumes proportion of PAF spoil samples approximates the proportion of fill in the TSF that are PAF.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low		

Table B17. AMD hazard scoring for source materials and likelihood for AMD generation from Bottom Dam TSF/reject landform (unrehabilitated)

Bottom Dam: Components (without cover)	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD source hazard score	Landform AMD hazard score (pre-rehabilitation)	Likelihood for AMD generation from Bottom Dam (before rehabilitation)
Tailings	95%	100%	95%	Based on limited data from 10 tailings samples from Bottom Dam TSF, all 10 tailings samples are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 0.90% ('PAF' samples). Conservatively assumes proportion of PAF tailings samples approximates the proportion of tailings in the TSF that are PAF. By way of comparison, based on data from 224 tailings samples originating from SCPP (ie. not just tailings sampled from Bottom Dam TSF), about 72% of SCPP tailings are classified as 'PAF', with 'PAF' samples having a 75th percentile S value of 0.70%. Therefore, the assessment - although based on only 10 samples - is conservative compared to the broader SCPP tailings database.	**15** High	**5** Moderate	**5** Moderate	**20** Moderate-High	**19** Moderate-High	The hazard for AMD generation in the landform is based on the majority (95%) of the landform being tailings of which all is conservatively estimated to be PAF. Most of the 10 tailings samples are displaying evidence of AD (pH <4.5) and/or with associated evidence of sulfide oxidation (to sulfate) and consumption of ANC. Overall, almost all of the current Bottom Dam TSF landform is conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material - almost all of which is tailings, which are assessed as posing a moderate-high AMD source hazard. Rejects are estimated to comprise about 4% of the TSF landform and are assessed as posing a moderate AMD source hazard. Spoil/fill is estimated to comprise about 1% of the landform and is assessed as posing a low AMD source hazard. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 1379 µS/cm. The hazard for AMD generation from Bottom Dam TSF landform is conservatively considered to be **MODERATE-HIGH**. The likelihood for AMD generation from Bottom Dam TSF landform is conservatively rated as **PROBABLE / LIKELY**.
Rejects	4%	71%	2.9%	No rejects samples available from Bottom Dam TSF - and it's unknown if any rejects are located within the TSF. Conservatively assumed rejects will comprise about 4% of the TSF. Based on the broader SCPP rejects database, up to 71% of rejects (originating from the SCPP) are conservatively classified as 'PAF', which includes samples classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 1.17% (PAF samples). NAF samples have a 75th percentile S value of 0.10%. 75th percentile EC of rejects = 1410 µS/cm. Rejects, despite being prodominantly classified as 'PAF', comprise an assumed small proportion (4%) of mineral waste in the landform and are assumed to be located within embankments.	**7** Expected	**7** Moderate-High	**7** Moderate-High	**14** Moderate		
Fill / Spoil Fill (assumed spoil) within the TSF, including within embankments. Excludes existing spoil (if any) on the surface of the TSF.	1%	2%	0.0%	Proportion of fill in TSF is uncertain; 1% is a conservative estimate. Based on data from all spoil samples - as a proxy for general fill commonly found in TSFs - up to 2% of fill is conservatively classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 0.52% ('PAF' samples). NAF samples have a 75th percentile S value of 0.04%. Conservatively assumes proportion of PAF spoil samples approximates the proportion of fill in the TSF that are PAF.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low		

Table B18. AMD hazard scoring for source materials and likelihood for AMD generation from Ramp 36 rejects landform (unrehabilitated)

Ramp 36 rejects dump: Components (without cover)	Estimated material proportion within landform	% of samples classified as PAF	% of material in landform estimated to be PAF	Comment	AMD propensity rating	AMD capacity rating	AMD quantity rating	AMD source hazard score	Landform AMD hazard score (pre-rehabilitation)	Likelihood for AMD generation from Ramp 36 rejects dump (before rehabilitation)
Tailings No tailings disposed into Ramp 36 rejects landform.	0%	0%	0%	No tailings located within Ramp 36 rejects landform.	n/a	n/a	n/a	n/a	**15** Moderate-High	The hazard for AMD generation in the landform is based on the landform being comprised almost entirely of rejects, of which 40% are conservatively estimated to be either PAF, PAF-LC, UC(PAF) or NAF-S material. The 75th percentile EC of the landform (based on the EC of the source materials proportionally represented) is estimated at 1508 µS/cm. The hazard for AMD generation from Ramp 36 Rejects landform is conservatively considered to be **MODERATE-HIGH**. The likelihood for AMD generation from Ramp 36 Rejects landform is conservatively rated as **PROBABLE / LIKELY**.
Rejects Essentially all of the landform is comprised of rejects	98%	40%	39%	The rejects dump is comprised almost entirely of rejects with a small proportion of fill material. Based on data from 144 rejects samples from Ramp 36 rejects dump, up to 40% of rejects are conservatively classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 1.40% ('PAF' samples). NAF samples have a 75th percentile S value of 0.79%. Conservatively assumes proportion of PAF and NAF-S rejects samples approximates the proportion of rejects in Ramp 36 rejects dump that are PAF and NAF-S. Assumes equal distribution of PAF/NAF rejects throughout the rejects dump.	**7** Expected	**7** Moderate-High	**10** High	**16** Moderate-High		
Fill / Spoil Fill (assumed spoil) within the rejects dump. Excludes existing spoil (if any) on the surface of the dump.	2%	2%	0%	Proportion of fill in rejects dump is uncertain; 2% is a conservative estimate, based on investigative drilling. Based on data from all spoil samples - as a proxy for general fill commonly found in old rejects dumps - up to 2% of fill is conservatively classified as PAF, PAF-LC, UC(PAF) or NAF-S. AMD capacity is based on a 75th percentile S value of 0.52% ('PAF' samples). NAF samples have a 75th percentile S value of 0.04%. Conservatively assumes proportion of PAF spoil samples approximates the proportion of fill in the TSF that are PAF.	**1** Implausible	**5** Moderate	**3** Low-Moderate	**5** Low		

Table B19. AMD hazard scoring for source materials and likelihood for AMD generation from Ramp 8 residual void walls and floor

Material domain	Material type	Proportion of drill-hole meterage on highwall by material type %	Above current water table (where known)	Below current water table (where known)	Proportion of drill-hole meterage (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on highwall	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	AMD Source Material Hazard Score	Likelihood for AMD generation from Ramp 8 void highwall
Ramp 8 Void Highwall	Weathered, non-carbonaceous	17%	100% (where known)	0% (where known)	0%	4.3%	Less than 4.5% of weathered non-carbonaceous samples (n=624) were PAF-LC [no "PAF" samples] (data from geochemical database). It is expected that weathered material is completely or predominantly oxidised and, as such, this material is overwhelmingly NAF.	0.7%	This material is expected to comprise approximately 17% of the void wall material by meterage. Assumed to be non-mineralised, with very low concentrations of reactive sulfide minerals. Small proportion of samples may be PAF (if so, likely low capacity). The potential for AMD from acid sulfate minerals (e.g. jarosite) is very low or negligible. Likely source of ANC. The 75th percentile total S value is 0.02%. AMD capacity based on PAF samples 75th percentile total S of 0.03%.	1	1	1	2	Highwall information is not available for Ramp 8, however the highwall is expected to be geologically comparable to Bonnie Doon Pit highwall. Based on Bonnie Doon highwall data, non-carb. rock is expected to have excess ANC, which should be sufficient to buffer AMD released from potential AMD sources exposed on the highwall, if any. The potential exposure of PAF materials on the highwall is estimated to represent approximately 4% (vertical meterage), with PAF domains expected to be largely confined to coal horizons/seams. Void wall run-off reporting to the residual void is unlikely to produce acidity. The hazard for AMD generation from Ramp 8 void highwall = **LOW**. The likelihood for AMD generation from Ramp 8 void highwall = **UNLIKELY**
	Weathered, carbonaceous & coaly	0.1%	100% (where known)	0% (where known)	0%	33%	Negligible proportion in highwall. Three out of 9 weathered carbonaceous/coaly samples were 'PAF' of some type (data from geochemical database). It is expected that weathered material is predominantly oxidised and, as such, this material is predominantly NAF or would pose a low AMD hazard.	<0.1%	This material is expected to comprise approximately 0.1% of the void wall material by meterage. Three (out of 9) samples were UC(PAF), and do not contain significant sulfide minerals. Being weathered, PAF materials are likely to be low capacity (i.e. PAF-LC). The potential for AMD from acid sulfate salts is low. The 75th percentile total S value is 0.43%. AMD capacity based on PAF samples 75th percentile total S of 1.11%.	5	7	1	9	
	Fresh, non-carbonaceous	73%	82% (where known)	18% (where known)	73%	0.9%	Less than 1% of fresh, non-carbonaceous samples were PAF (data from geochemical database) [31 out of 3515 samples]. Based on Bonnie Doon drillhole data, assume approximately 82% of this material is currently above the water table and would be potentially subject to oxidation.	0.7%	This material is estimated to comprise approximately 73% of the void wall material by meterage. Overall, fresh, non-carbonaceous spoil is overwhelmingly NAF with excess ANC. This material is likely to be an important source of ANC. Less than 1% of samples were PAF (of some type), and most were closely associated with coal seams (as roof, parting or floor). This material horizon is overwhelmingly NAF. The 75th percentile total S value for this material is 0.04%. AMD capacity based on PAF samples 75th percentile total S of 0.60%.	1	5	1	4	
	Fresh, carbonaceous	3.5%	81% (where known)	19% (where known)	3.5%	13%	Approximately 13% of fresh, carbonaceous samples (37 out of 283 samples) were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 81% of this material is currently above the water table and would be potentially subject to oxidation.	0.5%	Generation of AMD from fresh carbonaceous units cannot be excluded as 13% of the samples tested (all of BWM) were classed as PAF. However, this material is expected to comprise less than 4% of the void wall. Some carbonaceous overburden has excess ANC. The 75th percentile total S value for this material is 0.25%. AMD capacity based on PAF samples 75th percentile total S of 0.66%.	5	5	1	8	
	Coal (fresh)	6.7%	64% (where known)	36% (where known)	6.7%	36%	Approximately 36% of the 381 coal samples were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 64% of this material is currently above the water table and would be potentially subject to oxidation.	2.4%	Fresh coal is expected to comprise approximately 7% of the void wall material by meterage. Geochemical data is available for 381 coal samples sourced from across BWM seams, of which 136 samples were conservatively classified as 'PAF' of some type. Of these 'PAF' samples, 80% were classified as NAF-S, UC(PAF) or PAF-LC. The 75th percentile S value for PAF coal samples is 0.34% (and AMD capacity is based on this value). The 75th percentile S value for all coal samples is 0.32%. With regard to the coal quality database (n=7495 samples), the 75th percentile total S value is 0.48% - higher, but generally consistent with the smaller geochemical database. The seams/plys likely to be exposed on the highwall are predominantly the T, MR and P & L seam groups.	5	5	1	8	
	Unknown	0.0%	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	
	Estimated frequency of occurrence of PAF drill-hole intervals - assuming representativeness of surface exposure by drill-hole data							4.3%						

Material domain	Material type on void floor	Proportion of exposure on void floor % (assumed)	Above current water table	Below current water table	% Exposure (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on void floor	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	Likelihood for AMD generation from exposed Ramp 8 void floor	
Ramp 8 Void Floor	Coal: P & L Lower seam	100%	0%	100%	100%	3%	PAF proportion estimated by applying a total S 'cut-off' of 0.67% to the coal quality data for P&L Lower seam samples (2792 samples). The S cut-off was based on the median total S value for PAF coal, tailings and rejects samples (combined) from the geochemical database. 86 out of 2792 P&L Lower samples had total S ≥0.67%. Based on the geochemical database, 36% of 381 coal samples were conservatively classifed as PAF. Whereas, based on the much larger coal quality database (2792 samples), only 3% of the void floor is estimated to be PAF. All void floor is below the water table and would become submerged shortly after mining ceases.	3%	The floor of Ramp 8 void is expected to be P&L Lower seam group materials (coaly and carbonaceous materials), which has a 75th percentile total S value of 0.43% (based on 2792 P&L Lower samples in the coal quality database). AMD capacity is based on 75th percentile total S value of 1.14% for PAF coal, tailings and rejects samples (combined) from the geochemical database. Approximately 3% of P&L Lower seam coal samples from BWM have been classified as PAF. Limited data is available to assess the availability of ANC in coal samples, however ANC is largely available under field conditions from tailings and rejects samples - therefore coal would be expected to have similar ANC availability. Regardless, the potential for AMD generation from a small proportion of the void floor cannot be excluded - assuming the entire void floor comprises purely coal material. No allowance for pit flooding has been taken into account in this hazard assessment. Refer to report body for discussion regarding pit flooding.	1	7	1	5	Approximately 3% of the void floor may comprise PAF coal. The geochemical hazard for the void floor to develop AMD is low if the entire void floor comprises purely coal material (unlikely) and if the coal floor remains exposed to air (unlikely). As such, the actual AMD hazard post-closure will likely be lower than indicated. The likelihood for AMD generation from exposed void floor = **UNLIKELY**

Table B20. AMD hazard scoring for source materials and likelihood for AMD generation from Bonnie Doon residual void walls and floor

Material domain	Material type	Proportion of drill-hole meterage on highwall by material type %	Above current water table (where known)	Below current water table (where known)	Proportion of drill-hole meterage (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on highwall	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	AMD Source Material Hazard Score	Likelihood for AMD generation from Bonnie Doon void highwall
Bonnie Doon Void Highwall	Weathered, non-carbonaceous	17%	100% (where known)	0% (where known)	0%	4.3%	Less than 4.5% of weathered non-carbonaceous samples (n=624) were PAF-LC [no "PAF" samples] (data from geochemical database). It is expected that weathered material is completely or predominantly oxidised and, as such, this material is overwhelmingly NAF.	0.7%	This material is expected to comprise approximately 17% of the void wall material by meterage. Assumed to be non-mineralised, with very low concentrations of reactive sulfide minerals. Small proportion of samples may be PAF (if so, likely low capacity). The potential for AMD from acid sulfate minerals (e.g. jarosite) is very low or negligible. Likely source of ANC. The 75th percentile total S value is 0.02%. AMD capacity based on PAF samples 75th percentile total S of 0.03%.	1	1	1	2	Non-carbonaceous rock is expected to have excess acid neutralising capacity, which should be sufficient to buffer AMD released from potential AMD sources exposed on the highwall, if any. The potential exposure of PAF materials on the highwall is estimated to represent approximately 4% (vertical meterage). PAF domains are expected to be largely confined to coal horizons/seams. However, these will be embedded in a matrix of NAF and ANC-rich materials. Void wall run-off reporting to the residual void is unlikely to produce acidity. The hazard for AMD generation from Bonnie Doon void highwall = **LOW**. The likelihood for AMD generation from Bonnie Doon void highwall = **UNLIKELY**
	Weathered, carbonaceous & coaly	0.1%	100% (where known)	0% (where known)	0%	33%	Negligible proportion in highwall. Three out of 9 weathered carbonaceous/coaly samples were 'PAF' of some type (data from geochemical database). It is expected that weathered material is predominantly oxidised and, as such, this material is predominantly NAF or would pose a low AMD hazard.	<0.1%	This material is expected to comprise approximately 0.1% of the void wall material by meterage. Three (out of 9) samples were UC(PAF), and do not contain significant sulfide minerals. Being weathered, PAF materials are likely to be low capacity (i.e. PAF-LC). The potential for AMD from acid sulfate salts is low. The 75th percentile total S value is 0.43%. AMD capacity based on PAF samples 75th percentile total S of 1.11%.	5	7	1	9	
	Fresh, non-carbonaceous	73%	82% (where known)	18% (where known)	73%	0.9%	Less than 1% of fresh, non-carbonaceous samples were PAF (data from geochemical database) [31 out of 3515 samples]. Water table depths are not available for some highwall drillholes, however where known, approximately 82% of this material is currently above the water table and would be potentially subject to oxidation.	0.7%	This material is estimated to comprise approximately 73% of the void wall material by meterage. Overall, fresh, non-carbonaceous spoil is overwhelmingly NAF with excess ANC. This material is likely to be an important source of ANC. Less than 1% of samples were PAF (of some type), and most were closely associated with coal seams (as roof, parting or floor). This material horizon is overwhelmingly NAF. The 75th percentile total S value for this material is 0.04%. AMD capacity based on PAF samples 75th percentile total S of 0.60%.	1	5	1	4	
	Fresh, carbonaceous	3.5%	81% (where known)	19% (where known)	3.5%	13%	Approximately 13% of fresh, carbonaceous samples (37 out of 283 samples) were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 81% of this material is currently above the water table and would be potentially subject to oxidation.	0.5%	Generation of AMD from fresh carbonaceous units cannot be excluded as 13% of the samples tested (all of BWM) were classed as PAF. However, this material is expected to comprise less than 4% of the void wall. Some carbonaceous overburden has excess ANC. The 75th percentile total S value for this material is 0.25%. AMD capacity based on PAF samples 75th percentile total S of 0.66%.	5	5	1	8	
	Coal (fresh)	6.7%	64% (where known)	36% (where known)	6.7%	36%	Approximately 36% of the 381 coal samples were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 64% of this material is currently above the water table and would be potentially subject to oxidation.	2.4%	Fresh coal is expected to comprise approximately 7% of the void wall material by meterage. Geochemical data is available for 381 coal samples sourced from across BWM seams, of which 136 samples were conservatively classified as 'PAF' of some type. Of these 'PAF' samples, 80% were classified as NAF-S, UC(PAF) or PAF-LC. The 75th percentile S value for PAF coal samples is 0.34% (and AMD capacity is based on this value). The 75th percentile S value for all coal samples is 0.32%. With regard to the coal quality database (n=7495 samples), the 75th percentile total S value is 0.48% - higher, but generally consistent with the smaller geochemical database. The seams/plys likely to be exposed on the highwall are predominantly the T, MR and P & L seam groups.	5	5	1	8	
	Unknown	0.0%	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	
	Estimated frequency of occurrence of PAF drill-hole intervals - assuming representativeness of surface exposure by drill-hole data							4.3%						

Material domain	Material type on void floor	Proportion of exposure on void floor % (assumed)	Above current water table	Below current water table	% Exposure (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on void floor	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	Likelihood for AMD generation from exposed Bonnie Doon void floor
Bonnie Doon Void Floor	Tailings (from NCPP)	100%	0%	100%	100%	46%	No geochemical data is available from Bonnie Doon tailings specifically (Bonnie Doon Pit TSF). Based on geochemical data from NCPP tailings (being deposited into Bonnie Doon Pit), approximately 46% of tailings samples were 'PAF' or NAF-S (data from geochemical database) [143 out of 311 samples]. Assumes all tailings is below the post-closure water table and would become submerged after mining ceases - or would be capped/cover with a suitable thickness of spoil to minimise oxidation.	46%	The floor of Boonie Doon void is currently tailings and is expected to remain as such. 46% of NCPP tailings are conservatively classified as PAF, PAF-LC, UC(PAF) or NAF-S. 75th percentile EC of NCPP tailings = 918 µS/cm. AMD capacity is based on a 75th percentile S value of 2.29 for 'PAF' tailings. Some tailings samples will generate AD. AMD quantity assumes proportion of PAF tailings samples approximates the proportion of tailings that are PAF. ANC of tailings is largely available under field conditions. No allowance for pit flooding or potential cover over tailings has been taken into account in this hazard assessment. Refer to report body for discussion regarding tailings cover or pit flooding.	7	10	7	16	Approximately 46% of the void floor may comprise 'PAF' or NAF-S tailings.The geochemical hazard for the void floor to develop AMD is moderate-high if the tailings remains exposed to air (plausible). The likelihood for AMD generation from tailings on Bonnie Doon void floor = **PROBABLE/LIKELY**

Table B21. AMD hazard scoring for source materials and likelihood for AMD generation from Mimosa-Besgrove and Ramp 30S residual void walls and floor

Material domain	Material type	Proportion of drill-hole meterage on highwall by material type %	Above current water table (where known)	Below current water table (where known)	Proportion of drill-hole meterage (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on highwall	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	AMD Source Material Hazard Score	Likelihood for AMD generation from Mimosa-Besgrove & Ramp 30S voids highwall
Mimosa-Besgrove & Ramp 30S Voids Highwall	Weathered, non-carbonaceous	20%	67% (where known)	33% (where known)	0%	4.3%	Less than 4.5% of weathered non-carbonaceous samples (n=624) were PAF-LC [no "PAF" samples] (data from geochemical database). It is expected that weathered material is completely or predominantly oxidised and, as such, this material is overwhelmingly NAF.	0.9%	This material is expected to comprise approximately 20% of the void wall material by meterage. Assumed to be non-mineralised, with very low concentrations of reactive sulfide minerals. Small proportion of samples may be PAF (if so, likely low capacity). The potential for AMD from acid sulfate minerals (e.g. jarosite) is very low or negligible. Likely source of ANC. The 75th percentile total S value is 0.02%. AMD capacity based on PAF samples 75th percentile total S of 0.03%.	1	1	1	2	Non-carbonaceous rock is expected to have excess acid neutralising capacity, which should be sufficient to buffer AMD released from potential AMD sources exposed on the highwall, if any. The potential exposure of PAF materials on the highwall is estimated to represent approximately 4% (vertical meterage). PAF domains are expected to be largely confined to coal horizons/seams. However, these will be embedded in a matrix of NAF and ANC-rich materials. Void wall run-off reporting to the residual void is unlikely to produce acidity. The hazard for AMD generation from the highwall of Mimosa-Besgrove and Ramp 30 voids = **LOW**. The likelihood for AMD generation from the highwall of Mimosa-Besgrove and Ramp 30 voids = **UNLIKELY**
	Weathered, carbonaceous & coaly	0.6%	8% (where known)	92% (where known)	0%	33%	Negligible proportion in highwall. Three out of 9 weathered carbonaceous/coaly samples were 'PAF' of some type (data from geochemical database). It is expected that weathered material is predominantly oxidised and, as such, this material is predominantly NAF or would pose a low AMD hazard.	0.2%	This material is expected to comprise approximately 0.6% of the void wall material by meterage. Three (out of 9) samples were UC(PAF), and do not contain significant sulfide minerals. Being weathered, PAF materials are likely to be low capacity (i.e. PAF-LC). The potential for AMD from acid sulfate salts is low. The 75th percentile total S value is 0.43%. AMD capacity based on PAF samples 75th percentile total S of 1.11%.	5	7	1	9	
	Fresh, non-carbonaceous	70%	64% (where known)	36% (where known)	70%	0.9%	Less than 1% of fresh, non-carbonaceous samples were PAF (data from geochemical database) [31 out of 3515 samples]. Water table depths are not available for some highwall drillholes, however where known, approximately 64% of this material is currently above the water table and would be potentially subject to oxidation.	0.6%	This material is estimated to comprise approximately 70% of the void wall material by meterage. Overall, fresh, non-carbonaceous spoil is overwhelmingly NAF with excess ANC. This material is likely to be an important source of ANC. Less than 1% of samples were PAF (of some type), and most were closely associated with coal seams (as roof, parting or floor). This material horizon is overwhelmingly NAF. The 75th percentile total S value for this material is 0.04%. AMD capacity based on PAF samples 75th percentile total S of 0.60%.	1	5	1	4	
	Fresh, carbonaceous	1.2%	69% (where known)	31% (where known)	1.2%	13%	Approximately 13% of fresh, carbonaceous samples (37 out of 283 samples) were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 69% of this material is currently above the water table and would be potentially subject to oxidation.	0.2%	Generation of AMD from fresh carbonaceous units cannot be excluded as 13% of the samples tested (all of BWM) were classed as PAF. However, this material is expected to comprise approximately 1.2% of the void wall. Some carbonaceous overburden has excess ANC. The 75th percentile total S value for this material is 0.25%. AMD capacity based on PAF samples 75th percentile total S of 0.66%.	5	5	1	8	
	Coal (fresh)	5.4%	20% (where known)	80% (where known)	5.4%	36%	Approximately 36% of the 381 coal samples were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 20% of this material is currently above the water table and would be potentially subject to oxidation.	1.9%	Fresh coal is expected to comprise approximately 5.4% of the void wall material by meterage. Geochemical data is available for 381 coal samples sourced from across BWM seams, of which 136 samples were conservatively classified as 'PAF' of some type. Of these 'PAF' samples, 80% were classified as NAF-S, UC(PAF) or PAF-LC. The 75th percentile S value for PAF coal samples is 0.34% (and AMD capacity is based on this value). The 75th percentile S value for all coal samples is 0.32%. With regard to the coal quality database (n=7495 samples), the 75th percentile total S value is 0.48% - higher, but generally consistent with the smaller geochemical database. The seams/plys likely to be exposed on the highwall are predominantly the T, MR and P & L seam groups.	5	5	1	8	
	Unknown	2.4%	44%	55%	0.4%	0%	Lithology unknown. Approximately 18% of this material is below base of weathering (ie. fresh)	<0.1%	Negligible proportion; approximately 82% of this material is within weathered zone. Assume negligible PAF. Conservatively assume 'Moderate-High' AMD capacity.	1	7	1	5	
	Estimated frequency of occurrence of PAF drill-hole intervals - assuming representativeness of surface exposure by drill-hole data							3.8%						

Material domain	Material type on void floor	Proportion of exposure on void floor % (assumed)	Above current water table	Below current water table	% Exposure (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on void floor	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	Likelihood for AMD generation from exposed Mimosa-Besgrove & Ramp 30S void floor	
Mimosa-Besgrove & Ramp 30S Voids Floor	Coal: P & L Lower seam	100%	0%	100%	100%	3%	PAF proportion estimated by applying a total S 'cut-off' of 0.67% to the coal quality data for P&L Lower seam samples (2792 samples). The S cut-off was based on the median total S value for PAF coal, tailings and rejects samples (combined) from the geochemical database. 86 out of 2792 P&L Lower samples had total S ≥0.67%. Based on the geochemical database, 36% of 381 coal samples were conservatively classifed as PAF. Whereas, based on the much larger coal quality database (2792 samples), only 3% of the void floor is estimated to be PAF. All void floor is below the water table and would become submerged shortly after mining ceases.	3%	The floor of Mimosa-Besgrove void and Ramp 30 void is expected to be P&L Lower seam group materials (coaly and carbonaceous materials), which has a 75th percentile total S value of 0.43% (based on 2792 P&L Lower samples in the coal quality database). AMD capacity is based on 75th percentile total S value of 1.14% for PAF coal, tailings and rejects samples (combined) from the geochemical database. Approximately 3% of P&L Lower seam coal samples from BWM have been classified as PAF. Limited data is available to assess the availability of ANC in coal samples, however ANC is largely available under field conditions from tailings and rejects samples - therefore coal would be expected to have similar ANC availability. Regardless, the potential for AMD generation from a small proportion of the void floor cannot be excluded - assuming the entire void floor comprises purely coal material. No allowance for pit flooding has been taken into account in this hazard assessment. Refer to report body for discussion regarding pit flooding.	1	7	1	5	Approximately 3% of the void floor may comprise PAF coal. The geochemical hazard for the void floor to develop AMD is low if the entire void floor comprises purely coal material (unlikely) and if the coal floor remains exposed to air (unlikely). As such, the actual AMD hazard post-closure will likely be lower than indicated. The likelihood for AMD generation from exposed void floor = **UNLIKELY**

Table B22. AMD hazard scoring for source materials and likelihood for AMD generation from Deep Creek and Stewarton North residual void walls and floor

Material domain	Material type	Proportion of drill-hole meterage on highwall by material type %	Above current water table (where known)	Below current water table (where known)	Proportion of drill-hole meterage (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on highwall	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	AMD Source Material Hazard Score	Likelihood for AMD generation from Deep Creek & Stewarton North void highwall
Deep Creek & Stewarton North Void Highwall	Weathered, non-carbonaceous	22%	82% (where known)	18% (where known)	0%	4.3%	Less than 4.5% of weathered non-carbonaceous samples (n=624) were PAF-LC [no "PAF" samples] (data from geochemical database). It is expected that weathered material is completely or predominantly oxidised and, as such, this material is overwhelmingly NAF.	0.9%	This material is expected to comprise approximately 22% of the void wall material by meterage. Assumed to be non-mineralised, with very low concentrations of reactive sulfide minerals. Small proportion of samples may be PAF (if so, likely low capacity). The potential for AMD from acid sulfate minerals (e.g. jarosite) is very low or negligible. Likely source of ANC. The 75th percentile total S value is 0.02%. AMD capacity based on PAF samples 75th percentile total S of 0.03%.	1	1	1	2	Non-carbonaceous rock is expected to have excess acid neutralising capacity, which should be sufficient to buffer AMD released from potential AMD sources exposed on the highwall, if any. The potential exposure of PAF materials on the highwall is estimated to represent approximately 5% (vertical meterage). Most PAF domains are expected to be largely confined to coal horizons/ seams. However, these will be embedded in a matrix of NAF and ANC-rich materials. Void wall run-off reporting to the residual void is unlikely to produce acidity. The hazard for AMD generation from Deep Creek void highwall = **LOW**. The likelihood for AMD generation from Deep Creek void highwall = **UNLIKELY**
	Weathered, carbonaceous & coaly	1.0%	40% (where known)	60% (where known)	0%	33%	Negligible proportion in highwall. Three out of 9 weathered carbonaceous/coaly samples were 'PAF' of some type (data from geochemical database). It is expected that weathered material is prodominantly oxidised and, as such, this material is predominantly NAF or would pose a low AMD hazard.	0.3%	This material is expected to comprise approximately 1% of the void wall material by meterage. Three (out of 9) samples were UC(PAF), and do not contain significant sulfide minerals. Being weathered, PAF materials are likely to be low capacity (i.e. PAF-LC). The potential for AMD from acid sulfate salts is low. The 75th percentile total S value is 0.43%. AMD capacity based on PAF samples 75th percentile total S of 1.11%.	5	7	1	9	
	Fresh, non-carbonaceous	68%	63% (where known)	37% (where known)	68%	0.9%	Less than 1% of fresh, non-carbonaceous samples were PAF (data from geochemical database) [31 out of 3515 samples]. Water table depths are not available for some highwall drillholes, however where known, approximately 63% of this material is currently above the water table and would be potentially subject to oxidation.	0.6%	This material is estimated to comprise approximately 68% of the void wall material by meterage. Overall, fresh, non-carbonaceous spoil is overwhelmingly NAF with excess ANC. This material is likely to be an important source of ANC. Less than 1% of samples were PAF (of some type), and most were closely associated with coal seams (as roof, parting or floor). This material horizon is overwhelmingly NAF. The 75th percentile total S value for this material is 0.04%. AMD capacity based on PAF samples 75th percentile total S of 0.60%.	1	5	1	4	
	Fresh, carbonaceous	1.2%	45% (where known)	55% (where known)	1.2%	13%	Approximately 13% of fresh, carbonaceous samples (37 out of 283 samples) were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 45% of this material is currently above the water table and would be potentially subject to oxidation.	0.2%	Generation of AMD from fresh carbonaceous units cannot be excluded as 13% of the samples tested (all of BWM) were classed as PAF. However, this material is expected to comprise less than 1.5% of the void wall. Some carbonaceous overburden has excess ANC. The 75th percentile total S value for this material is 0.25%. AMD capacity based on PAF samples 75th percentile total S of 0.66%.	5	5	1	8	
	Coal (fresh)	7.1%	30% (where known)	70% (where known)	7.1%	36%	Approximately 36% of the 381 coal samples were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 30% of this material is currently above the water table and would be potentially subject to oxidation.	2.5%	Fresh coal is expected to comprise approximately 7% of the void wall material by meterage. Geochemical data is available for 381 coal samples sourced from across BWM seams, of which 136 samples were conservatively classified as 'PAF' of some type. Of these 'PAF' samples, 80% were classified as NAF-S, UC(PAF) or PAF-LC. The 75th percentile S value for PAF coal samples is 0.34% (and AMD capacity is based on this value). The 75th percentile S value for all coal samples is 0.32%. With regard to the coal quality database (n=7495 samples), the 75th percentile total S value is 0.48% - higher, but generally consistent with the smaller geochemical database. The seams/plys likely to be exposed on the highwall are predominantly the T, MR and P & L seam groups.	5	5	1	8	
	Unknown	0.6%	98%	2%	0%	0%	Lithology unknown. None of this material is below base of weathering (ie. all material is weathered)	<0.1%	Negligible proportion; all of this material is within weathered zone. Assume negligible PAF. Conservatively assume 'Moderate-High' AMD capacity.	1	7	1	5	
	Estimated frequency of occurrence of PAF drill-hole intervals - assuming representativeness of surface exposure by drill-hole data							4.6%						

Material domain	Material type on void floor	Proportion of exposure on void floor % (assumed)	Above current water table	Below current water table	% Exposure (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on void floor	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	Likelihood for AMD generation from exposed Deep Creek & Stewarton North void floor	
Deep Creek & Stewarton North Void Floor	Coal: P & L Lower seam	100%	0%	100%	100%	3%	PAF proportion estimated by applying a total S 'cut-off' of 0.67% to the coal quality data for P&L Lower seam samples (2792 samples). The S cut-off was based on the median total S value for PAF coal, tailings and rejects samples (combined) from the geochemical database. 86 out of 2792 P&L Lower samples had total S ≥0.67%. Based on the geochemical database, 36% of 381 coal samples were conservatively classifed as PAF. Whereas, based on the much larger coal quality database (2792 samples), only 3% of the void floor is estimated to be PAF. All void floor is below the water table and would become submerged shortly after mining ceases.	3%	The floor of Deep Creek and Stewarton North voids is expected to be P&L Lower seam group materials (coaly and carbonaceous materials), which has a 75th percentile total S value of 0.43% (based on 2792 P&L Lower samples in the coal quality database). AMD capacity is based on 75th percentile total S value of 1.14% for PAF coal, tailings and rejects samples (combined) from the geochemical database. Approximately 3% of P&L Lower seam coal samples from BWM have been classified as PAF. Limited data is available to assess the availability of ANC in coal samples, however ANC is largely available under field conditions from tailings and rejects samples - therefore coal would be expected to have similar ANC availability. Regardless, the potential for AMD generation from a small proportion of the void floor cannot be excluded - assuming the entire void floor comprises purely coal material. No allowance for pit flooding has been taken into account in this hazard assessment. Refer to report body for discussion regarding pit flooding.	1	7	1	5	Approximately 3% of the void floor may comprise PAF coal. The geochemical hazard for the void floor to develop AMD is low if the entire void floor comprises purely coal material (unlikely) and if the coal floor remains exposed to air (unlikely). As such, the actual AMD hazard post-closure will likely be lower than indicated. The likelihood for AMD generation from exposed void floor = **UNLIKELY**

Table B23. AMD hazard scoring for source materials and likelihood for AMD generation from Stewarton South, Tannyfoil and South Ballamoo residual void walls and floor

Material domain	Material type	Proportion of drill-hole meterage on highwall by material type %	Above current water table (where known)	Below current water table (where known)	Proportion of drill-hole meterage (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on highwall	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	AMD Source Material Hazard Score	Likelihood for AMD generation from Stewarton South, Tannyfoil and South Ballamoo voids highwall
Stewarton South, Tannyfoil and South Ballamoo Voids Highwall	Weathered, non-carbonaceous	23%	64% (where known)	36% (where known)	0%	4.3%	Less than 4.5% of weathered non-carbonaceous samples (n=624) were PAF-LC [no "PAF" samples] (data from geochemical database). It is expected that weathered material is completely or predominantly oxidised and, as such, this material is overwhelmingly NAF.	1.0%	This material is expected to comprise approximately 23% of the void wall material by meterage. Assumed to be non-mineralised, with very low concentrations of reactive sulfide minerals. Small proportion of samples may be PAF (if so, likely low capacity). The potential for AMD from acid sulfate minerals (e.g. jarosite) is very low or negligible. Likely source of ANC. The 75th percentile total S value is 0.02%. AMD capacity based on PAF samples 75th percentile total S of 0.03%.	1	1	1	2	Non-carbonaceous rock is expected to have excess acid neutralising capacity, which should be sufficient to buffer AMD released from potential AMD sources exposed on the highwall, if any. The potential exposure of PAF materials on the highwall is estimated to represent approximately 5% (vertical meterage). Most PAF domains are expected to be largely confined to coal horizons/ seams. However, these will be embedded in a matrix of NAF and ANC-rich materials. Void wall run-off reporting to the residual void is unlikely to produce acidity. The hazard for AMD generation from the highwall of Stewarton, Tannyfoil and South Ballamoo voids = **LOW**. The likelihood for AMD generation from the highwall of Stewarton, Tannyfoil and South Ballamoo voids = **UNLIKELY**
	Weathered, carbonaceous & coaly	1.6%	10% (where known)	90% (where known)	0%	33%	Negligible proportion in highwall. Three out of 9 weathered carbonaceous/coaly samples were 'PAF' of some type (data from geochemical database). It is expected that weathered material is predominantly oxidised and, as such, this material is predominantly NAF or would pose a low AMD hazard.	0.5%	This material is expected to comprise approximately 1.6% of the void wall material by meterage. Three (out of 9) samples were UC(PAF), and do not contain significant sulfide minerals. Being weathered, PAF materials are likely to be low capacity (i.e. PAF-LC). The potential for AMD from acid sulfate salts is low. The 75th percentile total S value is 0.43%. AMD capacity based on PAF samples 75th percentile total S of 1.11%.	5	7	1	9	
	Fresh, non-carbonaceous	65%	59% (where known)	41% (where known)	65%	0.9%	Less than 1% of fresh, non-carbonaceous samples were PAF (data from geochemical database) [31 out of 3515 samples]. Water table depths are not available for some highwall drillholes, however where known, approximately 59% of this material is currently above the water table and would be potentially subject to oxidation.	0.6%	This material is estimated to comprise approximately 65% of the void wall material by meterage. Overall, fresh, non-carbonaceous spoil is overwhelmingly NAF with excess ANC. This material is likely to be an important source of ANC. Less than 1% of samples were PAF (of some type), and most were closely associated with coal seams (as roof, parting or floor). This material horizon is overwhelmingly NAF. The 75th percentile total S value for this material is 0.04%. AMD capacity based on PAF samples 75th percentile total S of 0.60%.	1	5	1	4	
	Fresh, carbonaceous	1.1%	43% (where known)	57% (where known)	1.1%	13%	Approximately 13% of fresh, carbonaceous samples (37 out of 283 samples) were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 43% of this material is currently above the water table and would be potentially subject to oxidation.	0.1%	Generation of AMD from fresh carbonaceous units cannot be excluded as 13% of the samples tested (all of BWM) were classed as PAF. However, this material is expected to comprise approximately 1% of the void wall. Some carbonaceous overburden has excess ANC. The 75th percentile total S value for this material is 0.25%. AMD capacity based on PAF samples 75th percentile total S of 0.66%.	5	5	1	8	
	Coal (fresh)	7.2%	37% (where known)	63% (where known)	7.2%	36%	Approximately 36% of the 381 coal samples were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 37% of this material is currently above the water table and would be potentially subject to oxidation.	2.6%	Fresh coal is expected to comprise approximately 7% of the void wall material by meterage. Geochemical data is available for 381 coal samples sourced from across BWM seams, of which 136 samples were conservatively classified as 'PAF' of some type. Of these 'PAF' samples, 80% were classified as NAF-S, UC(PAF) or PAF-LC. The 75th percentile S value for PAF coal samples is 0.34% (and AMD capacity is based on this value). The 75th percentile S value for all coal samples is 0.32%. With regard to the coal quality database (n=7495 samples), the 75th percentile total S value is 0.48% - higher, but generally consistent with the smaller geochemical database. The seams/plys likely to be exposed on the highwall are predominantly the T, MR and P & L seam groups.	5	5	1	8	
	Unknown	1.7%	49%	51%	0.1%	0%	Lithology unknown. 7% of this material is below base of weathering (ie. fresh)	<0.1%	Negligible proportion; 93% of this material is within weathered zone. Assume negligible PAF. Conservatively assume 'Moderate-High' AMD capacity.	1	7	1	5	
	Estimated frequency of occurrence of PAF drill-hole intervals - assuming representativeness of surface exposure by drill-hole data							4.8%						

Material domain	Material type on void floor	Proportion of exposure on void floor % (assumed)	Above current water table	Below current water table	% Exposure (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on void floor	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	Likelihood for AMD generation from exposed Stewarton South, Tannyfoil and South Ballamoo void floor	
Stewarton South, Tannyfoil and South Ballamoo Voids Floor	Coal: P & L Lower seam	100%	0%	100%	100%	3%	PAF proportion estimated by applying a total S 'cut-off' of 0.67% to the coal quality data for P&L Lower seam samples (2792 samples). The S cut-off was based on the median total S value for PAF coal, tailings and rejects samples (combined) from the geochemical database. 86 out of 2792 P&L Lower samples had total S ≥0.67%. Based on the geochemical database, 36% of 381 coal samples were conservatively classifed as PAF. Whereas, based on the much larger coal quality database (2792 samples), only 3% of the void floor is estimated to be PAF. All void floor is below the water table and would become submerged shortly after mining ceases.	3%	The floor of Stewarton South, Tannyfoil and South Ballamoo voids is expected to be P&L Lower seam group materials (coaly and carbonaceous materials), which has a 75th percentile total S value of 0.43% (based on 2792 P&L Lower samples in the coal quality database). AMD capacity is based on 75th percentile total S value of 1.14% for PAF coal, tailings and rejects samples (combined) from the geochemical database. Approximately 3% of P&L Lower seam coal samples from BWM have been classified as PAF. Limited data is available to assess the availability of ANC in coal samples, however ANC is largely available under field conditions from tailings and rejects samples - therefore coal would be expected to have similar ANC availability. Regardless, the potential for AMD generation from a small proportion of the void floor cannot be excluded - assuming the entire void floor comprises purely coal material. No allowance for pit flooding has been taken into account in this hazard assessment. Refer to report body for discussion regarding pit flooding.	1	7	1	5	Approximately 3% of the void floor may comprise PAF coal. The geochemical hazard for the void floor to develop AMD is low if the entire void floor comprises purely coal material (unlikely) and if the coal floor remains exposed to air (unlikely). As such, the actual AMD hazard post-closure will likely be lower than indicated. The likelihood for AMD generation from exposed void floor = **UNLIKELY**

Table B24. AMD hazard scoring for source materials and likelihood for AMD generation from Kenmare residual void walls and floor

Material domain	Material type	Proportion of drill-hole meterage on highwall by material type %	Above current water table (where known)	Below current water table (where known)	Proportion of drill-hole meterage (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on highwall	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	AMD Source Material Hazard Score	Likelihood for AMD generation from Kenmare void highwall
Kenmare Void Highwall	Weathered, non-carbonaceous	25%	94% (where known)	6% (where known)	0%	4.3%	Less than 4.5% of weathered non-carbonaceous samples (n=624) were PAF-LC [no "PAF" samples] (data from geochemical database). It is expected that weathered material is completely or predominantly oxidised and, as such, this material is overwhelmingly NAF.	1.1%	This material is expected to comprise approximately 25% of the void wall material by meterage. Assumed to be non-mineralised, with very low concentrations of reactive sulfide minerals. Small proportion of samples may be PAF (if so, likely low capacity). The potential for AMD from acid sulfate minerals (e.g. jarosite) is very low or negligible. Likely source of ANC. The 75th percentile total S value is 0.02%. AMD capacity based on PAF samples 75th percentile total S of 0.03%.	1	1	1	2	Non-carbonaceous rock is expected to have excess acid neutralising capacity, which should be sufficient to buffer AMD released from potential AMD sources exposed on the highwall, if any. The potential exposure of PAF materials on the highwall is estimated to represent approximately 4% (vertical meterage). Most PAF domains are expected to be largely confined to coal horizons/ seams. However, these will be embedded in a matrix of NAF and ANC-rich materials. Void wall run-off reporting to the residual void is unlikely to produce acidity. The hazard for AMD generation from Kenmare void highwall = **LOW**. The likelihood for AMD generation from Kenmare void highwall = **UNLIKELY**
	Weathered, carbonaceous & coaly	0.01%	unk.	unk.	0%	33%	Negligible proportion in highwall. Three out of 9 weathered carbonaceous/coaly samples were 'PAF' of some type (data from geochemical database). It is expected that weathered material is predominantly oxidised and, as such, this material is predominantly NAF or would pose a low AMD hazard.	<0.1%	This material is expected to comprise less than 0.1% of the void wall material by meterage. Three (out of 9) samples were UC(PAF), and do not contain significant sulfide minerals. Being weathered, PAF materials are likely to be low capacity (i.e. PAF-LC). The potential for AMD from acid sulfate salts is low. The 75th percentile total S value is 0.43%. AMD capacity based on PAF samples 75th percentile total S of 1.11%.	5	7	1	9	
	Fresh, non-carbonaceous	65%	10% (where known)	90% (where known)	65%	0.9%	Less than 1% of fresh, non-carbonaceous samples were PAF (data from geochemical database) [31 out of 3515 samples]. Water table depths are not available for some highwall drillholes, however where known, approximately 10% of this material is currently above the water table and would be potentially subject to oxidation.	0.6%	This material is estimated to comprise approximately 65% of the void wall material by meterage. Overall, fresh, non-carbonaceous spoil is overwhelmingly NAF with excess ANC. This material is likely to be an important source of ANC. Less than 1% of samples were PAF (of some type), and most were closely associated with coal seams (as roof, parting or floor). This material horizon is overwhelmingly NAF. The 75th percentile total S value for this material is 0.04%. AMD capacity based on PAF samples 75th percentile total S of 0.60%.	1	5	1	4	
	Fresh, carbonaceous	1.2%	12% (where known)	88% (where known)	1.2%	13%	Approximately 13% of fresh, carbonaceous samples (37 out of 283 samples) were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 12% of this material is currently above the water table and would be potentially subject to oxidation.	0.2%	Generation of AMD from fresh carbonaceous units cannot be excluded as 13% of the samples tested (all of BWM) were classed as PAF. However, this material is expected to comprise less than 1.5% of the void highwall. Some carbonaceous overburden has excess ANC. The 75th percentile total S value for this material is 0.25%. AMD capacity based on PAF samples 75th percentile total S of 0.66%.	5	5	1	8	
	Coal (fresh)	5.1%	16% (where known)	84% (where known)	5.1%	36%	Approximately 36% of the 381 coal samples were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 16% of this material is currently above the water table and would be potentially subject to oxidation.	1.8%	Fresh coal is expected to comprise approximately 5% of the void wall material by meterage. Geochemical data is available for 381 coal samples sourced from across BWM seams, of which 136 samples were conservatively classified as 'PAF' of some type. Of these 'PAF' samples, 80% were classified as NAF-S, UC(PAF) or PAF-LC. The 75th percentile S value for PAF coal samples is 0.34% (and AMD capacity is based on this value). The 75th percentile S value for all coal samples is 0.32%. With regard to the coal quality database (n=7495 samples), the 75th percentile total S value is 0.48% - higher, but generally consistent with the smaller geochemical database. The seams/plys likely to be exposed on the highwall are predominantly the T and P & L seam groups.	5	5	1	8	
	Unknown	4.1%	99%	1%	1.7%	0%	Lithology unknown. 7% of this material is below base of weathering (ie. fresh)	<0.1%	Low proportion of the highwall; 55% of this material is within weathered zone. Assume negligible PAF. Conservatively assume 'Moderate-High' AMD capacity.	1	7	1	5	
	Estimated frequency of occurrence of PAF drill-hole intervals - assuming representativeness of surface exposure by drill-hole data							3.6%						

Material domain	Material type on void floor	Proportion of exposure on void floor % (assumed)	Above current water table	Below current water table	% Exposure (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on void floor	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	Likelihood for AMD generation from exposed Kenmare void floor	
Kenmare Void Floor	Coal: P & L Lower seam	100%	0%	100%	100%	3%	PAF proportion estimated by applying a total S 'cut-off' of 0.67% to the coal quality data for P&L Lower seam samples (2792 samples). The S cut-off was based on the median total S value for PAF coal, tailings and rejects samples (combined) from the geochemical database. 86 out of 2792 P&L Lower samples had total S ≥0.67%. Based on the geochemical database, 36% of 381 coal samples were conservatively classifed as PAF. Whereas, based on the much larger coal quality database (2792 samples), only 3% of the void floor is estimated to be PAF. All void floor is below the water table and would become submerged shortly after mining ceases.	3%	The floor of Kenmare void is expected to be P&L Lower seam group materials (coaly and carbonaceous materials), which has a 75th percentile total S value of 0.43% (based on 2792 P&L Lower samples in the coal quality database). AMD capacity is based on 75th percentile total S value of 1.14% for PAF coal, tailings and rejects samples (combined) from the geochemical database. Approximately 3% of P&L Lower seam coal samples from BWM have been classified as PAF. Limited data is available to assess the availability of ANC in coal samples, however ANC is largely available under field conditions from tailings and rejects samples - therefore coal would be expected to have similar ANC availability. Regardless, the potential for AMD generation from a small proportion of the void floor cannot be excluded - assuming the entire void floor comprises purely coal material. No allowance for pit flooding has been taken into account in this hazard assessment. Refer to report body for discussion regarding pit flooding.	1	7	1	5	Approximately 3% of the void floor may comprise PAF coal. The geochemical hazard for the void floor to develop AMD is low if the entire void floor comprises purely coal material (unlikely) and if the coal floor remains exposed to air (unlikely). As such, the actual AMD hazard post-closure will likely be lower than indicated. The likelihood for AMD generation from exposed void floor = **UNLIKELY**

Table B25. AMD hazard scoring for source materials and likelihood for AMD generation from Ramp 74 residual void walls and floor

Material domain	Material type	Proportion of drill-hole meterage on highwall by material type %	Above current water table (where known)	Below current water table (where known)	Proportion of drill-hole meterage (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on highwall	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	AMD Source Material Hazard Score	Likelihood for AMD generation from Ramp 74 (Laleham) void highwall
Ramp 74 (Laleham) Void Highwall	Weathered, non-carbonaceous	11%	100% (where known)	0% (where known)	0%	4.3%	Less than 4.5% of weathered non-carbonaceous samples (n=624) were PAF-LC [no "PAF" samples] (data from geochemical database). It is expected that weathered material is completely or predominantly oxidised and, as such, this material is overwhelmingly NAF.	0.5%	This material is expected to comprise approximately 11% of the void wall material by meterage. Assumed to be non-mineralised, with very low concentrations of reactive sulfide minerals. Small proportion of samples may be PAF (if so, likely low capacity). The potential for AMD from acid sulfate minerals (e.g. jarosite) is very low or negligible. Likely source of ANC. The 75th percentile total S value is 0.02%. AMD capacity based on PAF samples 75th percentile total S of 0.03%.	1	1	1	2	Non-carbonaceous rock is expected to have excess acid neutralising capacity, which should be sufficient to buffer AMD released from potential AMD sources exposed on the highwall, if any. The potential exposure of PAF materials on the highwall is estimated to represent less than 4% (vertical meterage). Most PAF domains are expected to be largely confined to coal horizons/ seams. However, these will be embedded in a matrix of NAF and ANC-rich materials. Void wall run-off reporting to the residual void is unlikely to produce acidity. The hazard for AMD generation from Ramp 74 void highwall = **LOW**. The likelihood for AMD generation from Ramp 74 void highwall = **UNLIKELY**
	Weathered, carbonaceous & coaly	0.01%	unk.	unk.	0%	33%	Negligible proportion in highwall. Three out of 9 weathered carbonaceous/coaly samples were 'PAF' of some type (data from geochemical database). It is expected that weathered material is predominantly oxidised and, as such, this material is predominantly NAF or would pose a low AMD hazard.	<0.1%	This material is expected to comprise less than 0.1% of the void wall material by meterage. Three (out of 9) samples were UC(PAF), and do not contain significant sulfide minerals. Being weathered, PAF materials are likely to be low capacity (i.e. PAF-LC). The potential for AMD from acid sulfate salts is low. The 75th percentile total S value is 0.43%. AMD capacity based on PAF samples 75th percentile total S of 1.11%.	5	7	1	9	
	Fresh, non-carbonaceous	82%	19% (where known)	81% (where known)	82%	0.9%	Less than 1% of fresh, non-carbonaceous samples were PAF (data from geochemical database) [31 out of 3515 samples]. Water table depths are not available for some highwall drillholes, however where known, approximately 19% of this material is currently above the water table and would be potentially subject to oxidation.	0.7%	This material is estimated to comprise approximately 82% of the void wall material by meterage. Overall, fresh, non-carbonaceous spoil is overwhelmingly NAF with excess ANC. This material is likely to be an important source of ANC. Less than 1% of samples were PAF (of some type), and most were closely associated with coal seams (as roof, parting or floor). This material horizon is overwhelmingly NAF. The 75th percentile total S value for this material is 0.04%. AMD capacity based on PAF samples 75th percentile total S of 0.60%.	1	5	1	4	
	Fresh, carbonaceous	0.8%	0% (where known)	100% (where known)	0.8%	13%	Approximately 13% of fresh, carbonaceous samples (37 out of 283 samples) were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, none of this material is currently above the water table and would be potentially subject to oxidation.	0.1%	Generation of AMD from fresh carbonaceous units cannot be excluded as 13% of the samples tested (all of BWM) were classed as PAF. However, this material is expected to comprise less than 1% of the void highwall. Some carbonaceous overburden has excess ANC. The 75th percentile total S value for this material is 0.25%. AMD capacity based on PAF samples 75th percentile total S of 0.66%.	5	5	1	8	
	Coal (fresh)	6.0%	0% (where known)	100% (where known)	6.0%	36%	Approximately 36% of the 381 coal samples were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, none of this material is currently above the water table and would be potentially subject to oxidation.	2.1%	Fresh coal is expected to comprise approximately 6% of the void wall material by meterage. Geochemical data is available for 381 coal samples sourced from across BWM seams, of which 136 samples were conservatively classified as 'PAF' of some type. Of these 'PAF' samples, 80% were classified as NAF-S, UC(PAF) or PAF-LC. The 75th percentile S value for PAF coal samples is 0.34% (and AMD capacity is based on this value). The 75th percentile S value for all coal samples is 0.32%. With regard to the coal quality database (n=7495 samples), the 75th percentile total S value is 0.48% - higher, but generally consistent with the smaller geochemical database. The seams/plys likely to be exposed on the highwall are predominantly the T and P & L seam groups.	5	5	1	8	
	Unknown	0.0%	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	Estimated frequency of occurrence of PAF drill-hole intervals - assuming representativeness of surface exposure by drill-hole data							3.5%						

Material domain	Material type on void floor	Proportion of exposure on void floor % (assumed)	Above current water table	Below current water table	% Exposure (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on void floor	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	Likelihood for AMD generation from exposed Ramp 74 (Laleham) void floor	
Ramp 74 (Laleham) Void Floor	Tailings (from SCPP)	100%	0%	100%	100%	72%	No geochemical data is available from Ramp 74 tailings (Laleham Pit TSF). Based on geochemical data from all tailings derived from SCPP, approximately 72% of tailings samples were PAF (data from geochemical database) [161 out of 224 samples]. Assumes all tailings is below the post-closure water table and would become submerged after mining ceases - or would be capped/cover with a suitable thickness of spoil and/or water cover to minimise oxidation.	72%	The floor of Ramp 74 void is currently tailings and is expected to remain as such. 72% of tailings derived from SCPP are conservatively classified as PAF, PAF-LC, UC(PAF) or NAF-S. 75th percentile EC of these tailings = 960 µS/cm. AMD capacity is based on a 75th percentile S value of 0.7% for 'PAF' samples from SCPP. Some tailings samples will generate AD. AMD quantity assumes proportion of PAF tailings samples approximates the proportion of tailings that are PAF. ANC of tailings is largely available under field conditions. No allowance for pit flooding or potential cover over tailings has been taken into account in this hazard assessment. Refer to report body for discussion regarding tailings cover or pit flooding.	7	5	7	13	Approximately 72% of the void floor may comprise PAF tailings.The geochemical hazard for the void floor to develop AMD is moderate if the tailings remains exposed to air (plausible). The likelihood for AMD generation from tailings on Ramp 74 void floor = **PROBABLE/LIKELY**

Table B26. AMD hazard scoring for source materials and likelihood for AMD generation from Togara-North Marshmead residual void walls and floor

Material domain	Material type	Proportion of drill-hole meterage on highwall by material type %	Above current water table (where known)	Below current water table (where known)	Proportion of drill-hole meterage (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on highwall	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	AMD Source Material Hazard Score	Likelihood for AMD generation from Togara-North Marshmead void highwall
Togara-North Marshmead Void Highwall	Weathered, non-carbonaceous	73%	21% (where known)	79% (where known)	0%	4.3%	Less than 4.5% of weathered non-carbonaceous samples (n=624) were PAF-LC [no "PAF" samples] (data from geochemical database). It is expected that weathered material is completely or predominantly oxidised and, as such, this material is overwhelmingly NAF.	3.1%	This material is expected to comprise approximately 73% of the void wall material by meterage. Assumed to be non-mineralised, with very low concentrations of reactive sulfide minerals. Small proportion of samples may be PAF (if so, likely low capacity). The potential for AMD from acid sulfate minerals (e.g. jarosite) is very low or negligible. Likely source of ANC. The 75th percentile total S value is 0.02%. AMD capacity based on PAF samples 75th percentile total S of 0.03%.	1	1	1	2	Non-carbonaceous rock is expected to have excess acid neutralising capacity, which should be sufficient to buffer AMD released from potential AMD sources exposed on the highwall, if any. Approximately 80% of the void highwall is expected to be weathered material. The potential exposure of PAF materials on the highwall is estimated to represent approximately 6% (vertical meterage). Most PAF domains are expected to be largely confined to coal horizons/ seams. However, these will be embedded in a matrix of NAF and ANC-rich materials. Void wall run-off reporting to the residual void is unlikely to produce acidity. The hazard for AMD generation from Togara-North Marshmead void highwall = **LOW**. The likelihood for AMD generation from Togara-North Marshmead void highwall = **UNLIKELY**
	Weathered, carbonaceous & coaly	5.6%	8% (where known)	92% (where known)	0%	33%	Negligible proportion in highwall. Three out of 9 weathered carbonaceous/coaly samples were 'PAF' of some type (data from geochemical database). It is expected that weathered material is predominantly oxidised and, as such, this material is predominantly NAF or would pose a low AMD hazard.	1.9%	This material is expected to comprise approximately 5.6% of the void wall material by meterage. Three (out of 9) samples were UC(PAF), and do not contain significant sulfide minerals. Being weathered, PAF materials are likely to be low capacity (i.e. PAF-LC). The potential for AMD from acid sulfate salts is low. The 75th percentile total S value is 0.43%. AMD capacity based on PAF samples 75th percentile total S of 1.11%.	5	7	1	9	
	Fresh, non-carbonaceous	19%	26% (where known)	74% (where known)	19%	0.9%	Less than 1% of fresh, non-carbonaceous samples were PAF (data from geochemical database) [31 out of 3515 samples]. Water table depths are not available for some highwall drillholes, however where known, approximately 26% of this material is currently above the water table and would be potentially subject to oxidation.	0.2%	This material is estimated to comprise approximately 19% of the void wall material by meterage. Overall, fresh, non-carbonaceous spoil is overwhelmingly NAF with excess ANC. This material is likely to be an important source of ANC. Less than 1% of samples were PAF (of some type), and most were closely associated with coal seams (as roof, parting or floor). This material horizon is overwhelmingly NAF. The 75th percentile total S value for this material is 0.04%. AMD capacity based on PAF samples 75th percentile total S of 0.60%.	1	5	1	4	
	Fresh, carbonaceous	0.4%	45% (where known)	55% (where known)	0.4%	13%	Approximately 13% of fresh, carbonaceous samples (37 out of 283 samples) were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 45% of this material is currently above the water table and would be potentially subject to oxidation.	<0.1%	Generation of AMD from fresh carbonaceous units cannot be excluded as 13% of the samples tested (all of BWM) were classed as PAF. However, this material is expected to comprise less than 0.5% of the void highwall. Some carbonaceous overburden has excess ANC. The 75th percentile total S value for this material is 0.25%. AMD capacity based on PAF samples 75th percentile total S of 0.66%.	5	5	1	8	
	Coal (fresh)	2.0%	47% (where known)	53% (where known)	2.0%	36%	Approximately 36% of the 381 coal samples were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 47% of this material is currently above the water table and would be potentially subject to oxidation.	0.7%	Fresh coal is expected to comprise approximately 2% of the void wall material by meterage. Geochemical data is available for 381 coal samples sourced from across BWM seams, of which 136 samples were conservatively classified as 'PAF' of some type. Of these 'PAF' samples, 80% were classified as NAF-S, UC(PAF) or PAF-LC. The 75th percentile S value for PAF coal samples is 0.34% (and AMD capacity is based on this value). The 75th percentile S value for all coal samples is 0.32%. With regard to the coal quality database (n=7495 samples), the 75th percentile total S value is 0.48% - higher, but generally consistent with the smaller geochemical database. The seams/plys likely to be exposed on the highwall are predominantly the T and P & L seam groups.	5	5	1	8	
	Unknown	0%	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**n/a**	
	Estimated frequency of occurrence of PAF drill-hole intervals - assuming representativeness of surface exposure by drill-hole data							5.9%						

Material domain	Material type on void floor	Proportion of exposure on void floor % (assumed)	Above current water table	Below current water table	% Exposure (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on void floor	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	Likelihood for AMD generation from exposed Togara-North Marshmead void floor	
Togara-North Marshmead Void Floor	Coal: P & L Lower seam	100%	0%	100%	100%	3%	PAF proportion estimated by applying a total S 'cut-off' of 0.67% to the coal quality data for P&L Lower seam samples (2792 samples). The S cut-off was based on the median total S value for PAF coal, tailings and rejects samples (combined) from the geochemical database. 86 out of 2792 P&L Lower samples had total S ≥0.67%. Based on the geochemical database, 36% of 381 coal samples were conservatively classifed as PAF. Whereas, based on the much larger coal quality database (2792 samples), only 3% of the void floor is estimated to be PAF. All void floor is below the water table and would become submerged shortly after mining ceases.	3%	The floor of Togara-North Marshmead void is expected to be P&L Lower seam group materials (coaly and carbonaceous materials), which has a 75th percentile total S value of 0.43% (based on 2792 P&L Lower samples in the coal quality database). AMD capacity is based on 75th percentile total S value of 1.14% for PAF coal, tailings and rejects samples (combined) from the geochemical database. Approximately 3% of P&L Lower seam coal samples from BWM have been classified as PAF. Limited data is available to assess the availability of ANC in coal samples, however ANC is largely available under field conditions from tailings and rejects samples - therefore coal would be expected to have similar ANC availability. Regardless, the potential for AMD generation from a small proportion of the void floor cannot be excluded - assuming the entire void floor comprises purely coal material. No allowance for pit flooding has been taken into account in this hazard assessment. Refer to report body for discussion regarding pit flooding.	1	7	1	5	Approximately 3% of the void floor may comprise PAF coal. The geochemical hazard for the void floor to develop AMD is low if the entire void floor comprises purely coal material (unlikely) and if the coal floor remains exposed to air (unlikely). As such, the actual AMD hazard post-closure will likely be lower than indicated. The likelihood for AMD generation from exposed void floor = **UNLIKELY**

Table B27. AMD hazard scoring for source materials and likelihood for AMD generation from South Marshmead residual void walls and floor

Material domain	Material type	Proportion of drill-hole meterage on highwall by material type %	Above current water table (where known)	Below current water table (where known)	Proportion of drill-hole meterage (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on highwall	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	AMD Source Material Hazard Score	Likelihood for AMD generation from South Marshmead void highwall
South Marshmead Void Highwall	Weathered, non-carbonaceous	59%	100% (where known)	0% (where known)	0%	4.3%	Less than 4.5% of weathered non-carbonaceous samples (n=624) were PAF-LC [no "PAF" samples] (data from geochemical database). It is expected that weathered material is completely or predominantly oxidised and, as such, this material is overwhelmingly NAF.	2.5%	This material is expected to comprise approximately 59% of the void wall material by meterage. Assumed to be non-mineralised, with very low concentrations of reactive sulfide minerals. Small proportion of samples may be PAF (if so, likely low capacity). The potential for AMD from acid sulfate minerals (e.g. jarosite) is very low or negligible. Likely source of ANC. The 75th percentile total S value is 0.02%. AMD capacity based on PAF samples 75th percentile total S of 0.03%.	1	1	1	2	Non-carbonaceous rock is expected to have excess acid neutralising capacity, which should be sufficient to buffer AMD released from potential AMD sources exposed on the highwall, if any. The potential exposure of PAF materials on the highwall is estimated to represent approximately 4% (vertical meterage). Most PAF domains are expected to be largely confined to coal horizons/ seams. However, these will be embedded in a matrix of NAF and ANC-rich materials. Void wall run-off reporting to the residual void is unlikely to produce acidity. The hazard for AMD generation from South Marshmead void highwall = **LOW**. The likelihood for AMD generation from South Marshmead void highwall = **UNLIKELY**
	Weathered, carbonaceous & coaly	1.3%	100% (where known)	0% (where known)	0%	33%	Negligible proportion in highwall. Three out of 9 weathered carbonaceous/coaly samples were 'PAF' of some type (data from geochemical database). It is expected that weathered material is prodominantly oxidised and, as such, this material is predominantly NAF or would pose a low AMD hazard.	0.4%	This material is expected to comprise approximately 1.3% of the void wall material by meterage. Three (out of 9) samples were UC(PAF), and do not contain significant sulfide minerals. Being weathered, PAF materials are likely to be low capacity (i.e. PAF-LC). The potential for AMD from acid sulfate salts is low. The 75th percentile total S value is 0.43%. AMD capacity based on PAF samples 75th percentile total S of 1.11%.	5	7	1	9	
	Fresh, non-carbonaceous	37%	100% (where known)	0% (where known)	37%	0.9%	Less than 1% of fresh, non-carbonaceous samples were PAF (data from geochemical database) [31 out of 3515 samples]. Water table depths are not available for some highwall drillholes, however where known, all of this material is currently above the water table and would be potentially subject to oxidation.	0.3%	This material is estimated to comprise approximately 37% of the void wall material by meterage. Overall, fresh, non-carbonaceous spoil is overwhelmingly NAF with excess ANC. This material is likely to be an important source of ANC. Less than 1% of samples were PAF (of some type), and most were closely associated with coal seams (as roof, parting or floor). This material horizon is overwhelmingly NAF. The 75th percentile total S value for this material is 0.04%. AMD capacity based on PAF samples 75th percentile total S of 0.60%.	1	5	1	4	
	Fresh, carbonaceous	0.7%	100% (where known)	0% (where known)	0.7%	13%	Approximately 13% of fresh, carbonaceous samples (37 out of 283 samples) were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, all of this material is currently above the water table and would be potentially subject to oxidation.	<0.1%	Generation of AMD from fresh carbonaceous units cannot be excluded as 13% of the samples tested (all of BWM) were classed as PAF. However, this material is expected to comprise less than 1% of the void highwall. Some carbonaceous overburden has excess ANC. The 75th percentile total S value for this material is 0.25%. AMD capacity based on PAF samples 75th percentile total S of 0.66%.	5	5	1	8	
	Coal (fresh)	2.5%	100% (where known)	0% (where known)	2.5%	36%	Approximately 36% of the 381 coal samples were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, all of this material is currently above the water table and would be potentially subject to oxidation.	0.9%	Fresh coal is expected to comprise approximately 2.5% of the void wall material by meterage. Geochemical data is available for 381 coal samples sourced from across BWM seams, of which 136 samples were conservatively classified as 'PAF' of some type. Of these 'PAF' samples, 80% were classified as NAF-S, UC(PAF) or PAF-LC. The 75th percentile S value for PAF coal samples is 0.34% (and AMD capacity is based on this value). The 75th percentile S value for all coal samples is 0.32%. With regard to the coal quality database (n=7495 samples), the 75th percentile total S value is 0.48% - higher, but generally consistent with the smaller geochemical database. The seams/plys likely to be exposed on the highwall are predominantly the T and P & L seam groups.	5	5	1	8	
	Unknown	0.0%	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	Estimated frequency of occurrence of PAF drill-hole intervals - assuming representativeness of surface exposure by drill-hole data							4.3%						

Material domain	Material type on void floor	Proportion of exposure on void floor % (assumed)	Above current water table	Below current water table	% Exposure (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on void floor	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	Likelihood for AMD generation from exposed South Marshmead void floor
South Marshmead Void Floor	Coal: P & L Lower seam	100%	0%	100%	100%	3%	PAF proportion estimated by applying a total S 'cut-off' of 0.67% to the coal quality data for P&L Lower seam samples (2792 samples). The S cut-off was based on the median total S value for PAF coal, tailings and rejects samples (combined) from the geochemical database. 86 out of 2792 P&L Lower samples had total S ≥0.67%. Based on the geochemical database, 36% of 381 coal samples were conservatively classifed as PAF. Whereas, based on the much larger coal quality database (2792 samples), only 3% of the void floor is estimated to be PAF. All void floor is below the water table and would become submerged shortly after mining ceases.	3%	The floor of South Marshmead void is expected to be P&L Lower seam group materials (coaly and carbonaceous materials), which has a 75th percentile total S value of 0.43% (based on 2792 P&L Lower samples in the coal quality database). AMD capacity is based on 75th percentile total S value of 1.14% for PAF coal, tailings and rejects samples (combined) from the geochemical database. Approximately 3% of P&L Lower seam coal samples from BWM have been classified as PAF. Limited data is available to assess the availability of ANC in coal samples, however ANC is largely available under field conditions from tailings and rejects samples - therefore coal would be expected to have similar ANC availability. Regardless, the potential for AMD generation from a small proportion of the void floor cannot be excluded - assuming the entire void floor comprises purely coal material. No allowance for pit flooding has been taken into account in this hazard assessment. Refer to report body for discussion regarding pit flooding.	1	7	1	5	Approximately 3% of the void floor may comprise PAF coal. The geochemical hazard for the void floor to develop AMD is low if the entire void floor comprises purely coal material (unlikely) and if the coal floor remains exposed to air (unlikely). As such, the actual AMD hazard post-closure will likely be lower than indicated. The likelihood for AMD generation from exposed void floor = **UNLIKELY**

Table B28. AMD hazard scoring for source materials and likelihood for AMD generation from Kennedy residual void walls and floor

Material domain	Material type	Proportion of drill-hole meterage on highwall by material type %	Above current water table (where known)	Below current water table (where known)	Proportion of drill-hole meterage (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on highwall	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	AMD Source Material Hazard Score	Likelihood for AMD generation from Kennedy void highwall
Kennedy Void Highwall	Weathered, non-carbonaceous	76%	99% (where known)	1% (where known)	0%	4.3%	Less than 4.5% of weathered non-carbonaceous samples (n=624) were PAF-LC [no "PAF" samples] (data from geochemical database). It is expected that weathered material is completely or predominantly oxidised and, as such, this material is overwhelmingly NAF.	3.3%	This material is expected to comprise approximately 76% of the void wall material by meterage. Assumed to be non-mineralised, with very low concentrations of reactive sulfide minerals. Small proportion of samples may be PAF (if so, likely low capacity). The potential for AMD from acid sulfate minerals (e.g. jarosite) is very low or negligible. Likely source of ANC. The 75th percentile total S value is 0.02%. AMD capacity based on PAF samples 75th percentile total S of 0.03%.	1	1	1	2	Non-carbonaceous rock is expected to have excess acid neutralising capacity, which should be sufficient to buffer AMD released from potential AMD sources exposed on the highwall, if any. The potential exposure of PAF materials on the highwall is estimated to represent approximately 5% (vertical meterage). Most PAF domains are expected to be largely confined to coal horizons/ seams. However, these will be embedded in a matrix of NAF and ANC-rich materials. Void wall run-off reporting to the residual void is unlikely to produce acidity. The hazard for AMD generation from Kennedy void highwall = **LOW**. The likelihood for AMD generation from Kennedy void highwall = **UNLIKELY**
	Weathered, carbonaceous & coaly	2.0%	92% (where known)	8% (where known)	0%	33%	Very low proportion in highwall. Three out of 9 weathered carbonaceous/coaly samples were 'PAF' of some type (data from geochemical database). It is expected that weathered material is prodominantly oxidised and, as such, this material is predominantly NAF or would pose a low AMD hazard.	0.7%	This material is expected to comprise approximately 2% of the void wall material by meterage. Three (out of 9) samples were UC(PAF), and do not contain significant sulfide minerals. Being weathered, PAF materials are likely to be low capacity (i.e. PAF-LC). The potential for AMD from acid sulfate salts is low. The 75th percentile total S value is 0.43%. AMD capacity based on PAF samples 75th percentile total S of 1.11%.	5	7	1	9	
	Fresh, non-carbonaceous	13%	22% (where known)	78% (where known)	13%	0.9%	Less than 1% of fresh, non-carbonaceous samples were PAF (data from geochemical database) [31 out of 3515 samples]. Water table depths are not available for some highwall drillholes, however where known, approximately 22% of this material is currently above the water table and would be potentially subject to oxidation.	0.1%	This material is estimated to comprise approximately 13% of the void wall material by meterage. Overall, fresh, non-carbonaceous spoil is overwhelmingly NAF with excess ANC. This material is likely to be an important source of ANC. Less than 1% of samples were PAF (of some type), and most were closely associated with coal seams (as roof, parting or floor). This material horizon is overwhelmingly NAF. The 75th percentile total S value for this material is 0.04%. AMD capacity based on PAF samples 75th percentile total S of 0.60%.	1	5	1	4	
	Fresh, carbonaceous	0.01%	unk.	unk.	0.01%	13%	Negligible proportion in highwall. Approximately 13% of fresh, carbonaceous samples (37 out of 283 samples) were 'PAF' of some type (data from geochemical database).	<0.1%	Generation of AMD from fresh carbonaceous units cannot be excluded as 13% of the samples tested (all of BWM) were classed as PAF. However, this material is expected to comprise less than 0.1% of the void highwall. Some carbonaceous overburden has excess ANC. The 75th percentile total S value for this material is 0.25%. AMD capacity based on PAF samples 75th percentile total S of 0.66%.	5	5	1	8	
	Coal (fresh)	1.9%	0% (where known)	100% (where known)	1.9%	36%	Approximately 36% of the 381 coal samples were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, all of this material is currently below the water table and would not be potentially subject to oxidation.	0.7%	Fresh coal is expected to comprise approximately 2% of the void wall material by meterage. Geochemical data is available for 381 coal samples sourced from across BWM seams, of which 136 samples were conservatively classified as 'PAF' of some type. Of these 'PAF' samples, 80% were classified as NAF-S, UC(PAF) or PAF-LC. The 75th percentile S value for PAF coal samples is 0.34% (and AMD capacity is based on this value). The 75th percentile S value for all coal samples is 0.32%. With regard to the coal quality database (n=7495 samples), the 75th percentile total S value is 0.48% - higher, but generally consistent with the smaller geochemical database. The seams/plys likely to be exposed on the highwall are predominantly the T and P & L seam groups.	5	5	1	8	
	Unknown	6.8%	100%	0%	1.7%	6%	Lithology unknown. All of this material is below base of weathering (ie. fresh). Assume %PAF based on average of fresh spoil materials	0.4%	All of this material is below base of weathering. Assume low PAF. Conservatively assume 'Moderate-High' AMD capacity. Conservative AMD hazard score.	5	5	1	8	
	Estimated frequency of occurrence of PAF drill-hole intervals - assuming representativeness of surface exposure by drill-hole data							5.1%						

Material domain	Material type on void floor	Proportion of exposure on void floor % (assumed)	Above current water table	Below current water table	% Exposure (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on void floor	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	Likelihood for AMD generation from exposed Kennedy void floor	
Kennedy Void Floor	Coal: P & L Lower seam	100%	0%	100%	100%	3%	PAF proportion estimated by applying a total S 'cut-off' of 0.67% to the coal quality data for P&L Lower seam samples (2792 samples). The S cut-off was based on the median total S value for PAF coal, tailings and rejects samples (combined) from the geochemical database. 86 out of 2792 P&L Lower samples had total S ≥0.67%. Based on the geochemical database, 36% of 381 coal samples were conservatively classifed as PAF. Whereas, based on the much larger coal quality database (2792 samples), only 3% of the void floor is estimated to be PAF. All void floor is below the water table and would become submerged shortly after mining ceases.	3%	The floor of Kennedy void is expected to be P&L Lower seam group materials (coaly and carbonaceous materials), which has a 75th percentile total S value of 0.43% (based on 2792 P&L Lower samples in the coal quality database). AMD capacity is based on 75th percentile total S value of 1.14% for PAF coal, tailings and rejects samples (combined) from the geochemical database. Approximately 3% of P&L Lower seam coal samples from BWM have been classified as PAF. Limited data is available to assess the availability of ANC in coal samples, however ANC is largely available under field conditions from tailings and rejects samples - therefore coal would be expected to have similar ANC availability. Regardless, the potential for AMD generation from a small proportion of the void floor cannot be excluded - assuming the entire void floor comprises purely coal material. No allowance for pit flooding has been taken into account in this hazard assessment. Refer to report body for discussion regarding pit flooding.	1	7	1	5	Approximately 3% of the void floor may comprise PAF coal. The geochemical hazard for the void floor to develop AMD is low if the entire void floor comprises purely coal material (unlikely) and if the coal floor remains exposed to air (unlikely). As such, the actual AMD hazard post-closure will likely be lower than indicated. The likelihood for AMD generation from exposed void floor = **UNLIKELY**

Table B29 AMD hazard scoring for source materials and likelihood for AMD generation from Comet Downs East residual void walls and floor

Material domain	Material type	Proportion of drill-hole meterage on highwall by material type %	Above current water table (where known)	Below current water table (where known)	Proportion of drill-hole meterage (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on highwall	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	AMD Source Material Hazard Score	Likelihood for AMD generation from Comet Downs East void highwall
Comet Downs East Void Highwall	Weathered, non-carbonaceous	33%	99% (where known)	1% (where known)	0%	4.3%	Less than 4.5% of weathered non-carbonaceous samples (n=624) were PAF-LC [no "PAF" samples] (data from geochemical database). It is expected that weathered material is completely or predominantly oxidised and, as such, this material is overwhelmingly NAF.	1.4%	This material is expected to comprise approximately 33% of the void wall material by meterage. Assumed to be non-mineralised, with very low concentrations of reactive sulfide minerals. Small proportion of samples may be PAF (if so, likely low capacity). The potential for AMD from acid sulfate minerals (e.g. jarosite) is very low or negligible. Likely source of ANC. The 75th percentile total S value is 0.02%. AMD capacity based on PAF samples 75th percentile total S of 0.03%.	1	1	1	2	Non-carbonaceous rock is expected to have excess acid neutralising capacity, which should be sufficient to buffer AMD released from potential AMD sources exposed on the highwall, if any. The potential exposure of PAF materials on the highwall is estimated to represent approximately 4% (vertical meterage). Most PAF domains are expected to be largely confined to coal horizons/ seams. However, these will be embedded in a matrix of NAF and ANC-rich materials. Void wall run-off reporting to the residual void is unlikely to produce acidity. The hazard for AMD generation from Comet Downs East void highwall = **LOW**. The likelihood for AMD generation from Comet Downs East void highwall = **UNLIKELY**
	Weathered, carbonaceous & coaly	0.6%	100% (where known)	0% (where known)	0%	33%	Negligible proportion in highwall. Three out of 9 weathered carbonaceous/coaly samples were 'PAF' of some type (data from geochemical database). It is expected that weathered material is predominantly oxidised and, as such, this material is predominantly NAF or would pose a low AMD hazard.	0.2%	This material is expected to comprise less than 1% of the void wall material by meterage. Three (out of 9) samples were UC(PAF), and do not contain significant sulfide minerals. Being weathered, PAF materials are likely to be low capacity (i.e. PAF-LC). The potential for AMD from acid sulfate salts is low. The 75th percentile total S value is 0.43%. AMD capacity based on PAF samples 75th percentile total S of 1.11%.	5	7	1	9	
	Fresh, non-carbonaceous	54%	88% (where known)	12% (where known)	54%	0.9%	Less than 1% of fresh, non-carbonaceous samples were PAF (data from geochemical database) [31 out of 3515 samples]. Water table depths are not available for some highwall drillholes, however where known, approximately 88% of this material is currently above the water table and would be potentially subject to oxidation.	0.5%	This material is estimated to comprise approximately 54% of the void wall material by meterage. Overall, fresh, non-carbonaceous spoil is overwhelmingly NAF with excess ANC. This material is likely to be an important source of ANC. Less than 1% of samples were PAF (of some type), and most were closely associated with coal seams (as roof, parting or floor). This material horizon is overwhelmingly NAF. The 75th percentile total S value for this material is 0.04%. AMD capacity based on PAF samples 75th percentile total S of 0.60%.	1	5	1	4	
	Fresh, carbonaceous	3.0%	47% (where known)	53% (where known)	3.0%	13%	Approximately 13% of fresh, carbonaceous samples (37 out of 283 samples) were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 47% of this material is currently above the water table and would be potentially subject to oxidation.	0.4%	Generation of AMD from fresh carbonaceous units cannot be excluded as 13% of the samples tested (all of BWM) were classed as PAF. However, this material is expected to comprise approximately 3% of the void highwall. Some carbonaceous overburden has excess ANC. The 75th percentile total S value for this material is 0.25%. AMD capacity based on PAF samples 75th percentile total S of 0.66%.	5	5	1	8	
	Coal (fresh)	3.3%	84% (where known)	16% (where known)	3.3%	36%	Approximately 36% of the 381 coal samples were 'PAF' of some type (data from geochemical database). Water table depths are not available for some highwall drillholes, however where known, approximately 84% of this material is currently above the water table and would be potentially subject to oxidation.	1.2%	Fresh coal is expected to comprise approximately 3.3% of the void wall material by meterage. Geochemical data is available for 381 coal samples sourced from across BWM seams, of which 136 samples were conservatively classified as 'PAF' of some type. Of these 'PAF' samples, 80% were classified as NAF-S, UC(PAF) or PAF-LC. The 75th percentile S value for PAF coal samples is 0.34% (and AMD capacity is based on this value). The 75th percentile S value for all coal samples is 0.32%. With regard to the coal quality database (n=7495 samples), the 75th percentile total S value is 0.48% - higher, but generally consistent with the smaller geochemical database. The seams/plys likely to be exposed on the highwall are predominantly the T and P & L seam groups.	5	5	1	8	
	Unknown	6.3%	100%	0%	0%	0%	Lithology unknown. None of this material is below base of weathering (ie. all material is weathered)	<0.1%	All of this material is within weathered zone. Assume negligible PAF. Conservatively assume 'Moderate-High' AMD capacity.	1	7	1	5	
	Estimated frequency of occurrence of PAF drill-hole intervals - assuming representativeness of surface exposure by drill-hole data							3.7%						

Material domain	Material type on void floor	Proportion of exposure on void floor % (assumed)	Above current water table	Below current water table	% Exposure (below base of weathering)	% of PAF sample by material type (environmental and/or coal database)	Comment	Estimated % PAF exposure on void floor	Comment	Geochemical Propensity for AMD	AMD Capacity Rating	AMD Quantity Rating	Likelihood for AMD generation from exposed Comet Downs East void floor
Comet Downs East Void Floor	Coal: P & L Lower seam	100%	0%	100%	100%	3%	PAF proportion estimated by applying a total S 'cut-off' of 0.67% to the coal quality data for P&L Lower seam samples (2792 samples). The S cut-off was based on the median total S value for PAF coal, tailings and rejects samples (combined) from the geochemical database. 86 out of 2792 P&L Lower samples had total S ≥0.67%. Based on the geochemical database, 36% of 381 coal samples were conservatively classifed as PAF. Whereas, based on the much larger coal quality database (2792 samples), only 3% of the void floor is estimated to be PAF. All void floor is below the water table and would become submerged shortly after mining ceases.	3%	The floor of Comet void is expected to be P&L Lower seam group materials (coaly and carbonaceous materials), which has a 75th percentile total S value of 0.43% (based on 2792 P&L Lower samples in the coal quality database). AMD capacity is based on 75th percentile total S value of 1.14% for PAF coal, tailings and rejects samples (combined) from the geochemical database. Approximately 3% of P&L Lower seam coal samples from BWM have been classified as PAF. Limited data is available to assess the availability of ANC in coal samples, however ANC is largely available under field conditions from tailings and rejects samples - therefore coal would be expected to have similar ANC availability. Regardless, the potential for AMD generation from a small proportion of the void floor cannot be excluded - assuming the entire void floor comprises purely coal material. No allowance for pit flooding has been taken into account in this hazard assessment. Refer to report body for discussion regarding pit flooding.	1	7	1	5	Approximately 3% of the void floor may comprise PAF coal. The geochemical hazard for the void floor to develop AMD is low if the entire void floor comprises purely coal material (unlikely) and if the coal floor remains exposed to air (unlikely). As such, the actual AMD hazard post-closure will likely be lower than indicated. The likelihood for AMD generation from exposed void floor = **UNLIKELY**

Appendix C – SPR Assessment Tables

SPR assessment of post-closure spoil landform (source) to surface water (receptor)

- Table C1 Ramp 8 spoil landform
- Table C2 Bonnie Doon spoil landform
- Table C3 Mimosa-Besgrove spoil landform
- Table C4 Deep Creek spoil landform
- Table C5 Stewarton spoil landform
- Table C6 Tannyfoil spoil landform
- Table C7 South Ballamoo (Terang) spoil landform
- Table C8 Blackdown spoil landform
- Table C9 Kenmare spoil landform
- Table C10 Ramp 74 spoil landform
- Table C11 Togara-North Marshmead spoil landform
- Table C12 South Marshmead spoil landform
- Table C13 Kennedy spoil landform
- Table C14 Comet Downs East spoil landform

SPR assessment of post-closure TSF and rejects landforms (source) to surface water (receptor)

- Table C15 NCPP TSF landform
- Table C16 Laleham TSF landform
- Table C17 Bottom Dam TSF (and rejects) landform
- Table C18 Ramp 36 rejects landform

SPR assessment of post-closure spoil landform (source) to residual void (receptor)

- Table C19 Ramp 8, Bonnie Doon, Mimosa-Besgrove and Deep Creek spoil landforms
- Table C20 Stewarton, Tannyfoil, Blackdown and South Ballamoo spoil landforms
- Table C21 Kenmare, Ramp 74 and Togara-North Marshmead spoil landforms
- Table C22 South Marshmead, Kennedy and Comet Downs East spoil landforms

SPR assessment of post-closure TSF and rejects landform (source) to residual void (receptor)

- Table C23 TSF landforms (NCPP, Laleham, Bottom Dam) and Ramp 36 rejects landform

SPR assessment of residual void walls and floor (source) to residual void (receptor)

- Table C24 All residual voids

Table C1. Source-Pathway-Receptor (SPR) assessment of Ramp 8 spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Ramp 8 spoil landform (post-closure) Comprised of approximately 96% non-carbonaceous spoil and approximately 4% carbonaceous spoil. No rejects or tailings *AMD source hazard of landform is* ***Low*** *Salinity (non-oxidative) source hazard of landform:* ***Low***	From Ramp 8 spoil landform via surface water run-off into ephemeral tributary of Bonnie Doon Creek. Distance <100m to receptor (west). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): tributary of Bonnie Doon Creek @ western side of Ramp 8 spoil landform. *Potential for AMD to reach Bonnie Doon Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Bonnie Doon Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributary of Bonnie Doon Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting tributary of Bonnie Doon Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributary of Bonnie Doon Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting tributary of Bonnie Doon Creek [via run-off]	Unlikely	S1	**Low**
	From Ramp 8 spoil landform via seepage into shallow permeable strata then into ephemeral tributary of Bonnie Doon Creek. Distance <100m to receptor (west). *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata: tributary of Bonnie Doon Creek @ western side of Ramp 8 spoil landform. *Potential for AMD to reach Bonnie Doon Creek:* ***Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Bonnie Doon Creek:* ***Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributary of Bonnie Doon Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting tributary of Bonnie Doon Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributary of Bonnie Doon Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting tributary of Bonnie Doon Creek [via seepage]	Unlikely	S1	**Low**

Table C2. Source-Pathway-Receptor (SPR) assessment of Bonnie Doon spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Bonnie Doon spoil landform (post-closure) Comprised of approximately 96% non-carbonaceous spoil and approximately 4% carbonaceous spoil. No rejects or tailings *AMD source hazard of landform is* ***Low*** *Salinity (non-oxidative) source hazard of landform:* ***Low***	From Bonnie Doon spoil landform via surface water run-off into ephemeral Bonnie Doon Creek (and tributary). Distance <100m to receptor (northwest) and ~900m (west). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): Bonnie Doon Creek (and tributary) @ western side of Bonnie Doon spoil landform. *Potential for AMD to reach Bonnie Doon Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Bonnie Doon Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Bonnie Doon Creek and tributary [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Bonnie Doon Creek and tributary [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Bonnie Doon Creek and tributary [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Bonnie Doon Creek and tributary [via run-off]	Unlikely	S1	**Low**
	From Bonnie Doon spoil landform via seepage into shallow permeable strata then into ephemeral Bonnie Doon Creek (and tributary). Distance <100m to receptor (northwest) and ~900 (west). *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata: Bonnie Doon Creek (and tributary) @ western side of Bonnie Doon spoil landform. *Potential for AMD to reach Bonnie Doon Creek:* ***Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Bonnie Doon Creek:* ***Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Bonnie Doon Creek and tributary [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Bonnie Doon Creek and tributary [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Bonnie Doon Creek and tributary [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Bonnie Doon Creek and tributary [via seepage]	Unlikely	S1	**Low**

Table C3. Source-Pathway-Receptor (SPR) assessment of Mimosa-Besgrove spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Mimosa-Besgrove spoil landform (post-closure) Comprised of approximately 95% non-carbonaceous spoil; approximately 2.9% carbonaceous spoil; and approximately 1.9% rejects. Deep Creek rejects dump (now buried within landform) is located <100m from southern toe of landform No tailings *AMD source hazard of landform is* ***Low*** *Salinity (non-oxidative) source hazard of landform is* ***Low*** *[AMD source hazard of rejects alone is* ***Moderate****, which has implications, specifically, for buried rejects at Deep Creek (Ramp 32) rejects area [ie. largely concentrated in one area]. Buried Deep Creek rejects are located <100m from southern toe of landform, which is <100m from Deep Creek]* (***Figure 34***)	From Mimosa-Besgrove spoil landform via surface water run-off into ephemeral Burngrove Creek and tributaries. Distance <200m to receptor (west). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): tributaries of Burngrove Creek @ western side of Mimosa-Besgrove spoil landform. *Potential for AMD to reach tributaries of Burngrove Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach tributaries of Burngrove Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributaries of Burngrove Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting tributaries of Burngrove Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributaries of Burngrove Ck [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting tributaries of Burngrove Creek [via run-off]	Unlikely	S1	**Low**
	From Mimosa-Besgrove spoil landform via seepage into shallow permeable strata then into ephemeral Burngrove Creek and tributaries. Distance <200m to receptor (west). *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata: tributaries of Burngrove Creek @ western side of Mimosa-Besgrove spoil landform. *Potential for AMD to reach tributaries of Burngrove Creek:* ***Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach tributaries of Burngrove Creek:* ***Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributaries of Burngrove Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting tributaries of Burngrove Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributaries of Burngrove Ck [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting tributaries of Burngrove Creek [via seepage]	Unlikely	S1	**Low**
	From Mimosa-Besgrove spoil landform via surface water run-off into ephemeral Deep Creek. Distance <100m to receptor (south). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): Deep Creek @ southern side of Mimosa-Besgrove spoil landform. *Potential for AMD to reach Deep Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Deep Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Deep Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Deep Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Deep Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Deep Creek [via run-off]	Unlikely	S1	**Low**
	From Mimosa-Besgrove spoil landform via seepage into shallow permeable strata then into ephemeral Deep Creek. Distance <100m to receptor (south). *Potential for AMD to enter shallow groundwater:* ***Probable/Likely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Probable/Likely***	Ephemeral creek (via shallow permeable strata: Deep Creek @ southern side of Mimosa-Besgrove spoil landform. *Potential for AMD to reach Deep Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Deep Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Deep Creek [via seepage] Risk primarily lies with seepage from buried rejects concentrated at Deep Creek (R32) rejects area	Unlikely	S3	**Low to Medium**
			Neutral metalliferous drainage: Metals and metalloids impacting Deep Creek [via seepage] Risk primarily lies with seepage from buried rejects concentrated at Deep Creek (R32) rejects area	Unlikely	S3	**Low to Medium**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Deep Creek [via seepage] Risk primarily lies with seepage from buried rejects concentrated at Deep Creek (R32) rejects area	Unlikely	S3	**Low to Medium**
			Saline drainage (non-oxidative): Salt impacting Deep Creek [via seepage] Risk primarily lies with seepage from buried rejects concentrated at Deep Creek (R32) rejects area	Unlikely	S2	**Low**

Table C4. Source-Pathway-Receptor (SPR) assessment of Deep Creek spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Deep Creek spoil landform (post-closure) Comprised of approximately 96% non-carbonaceous spoil; approximately 3% carbonaceous spoil; and approximately 1% rejects. No tailings *AMD source hazard of landform is* ***Low*** *Salinity (non-oxidative) source hazard of landform is* ***Low*** *AMD source hazard of rejects alone is* ***Moderate****. Rejects are widely distributed throughout the landform and comprise a very low proportion of the landform.*	From Deep Creek spoil landform via surface water run-off into ephemeral Deep Creek. Distance <100m to receptor (north and northwest). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): Deep Creek @ northern and northwestern side of Deep Creek spoil landform. *Potential for AMD to reach Deep Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Deep Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Deep Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Deep Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Deep Creek [via run-off]	Unlikely	S1	**Low**
	From Deep Creek spoil landform via seepage into shallow permeable strata then into ephemeral Deep Creek. Distance <100m to receptor (north and northwest). *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata: Deep Creek @ northern and northwestern side of Deep Creek spoil landform. *Potential for AMD to reach Deep Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Deep Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Deep Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Deep Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Deep Creek [via seepage]	Unlikely	S1	**Low**
	From Deep Creek spoil landform via surface water run-off into ephemeral tributaries Taurus Creek. Distance ~400m to receptor (west). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): tributaries of Taurus Creek @ western side of Deep Creek landform. *Potential for AMD to reach tributaries of Taurus Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach tributaries of Taurus Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributaries of Taurus Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals / metalloids impacting tributaries of Taurus Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributaries of Taurus Ck [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting tributaries of Taurus Creek [via run-off]	Unlikely	S1	**Low**
	From Deep Creek spoil landform via seepage into shallow permeable strata then into ephemeral tributaries of Taurus Creek. Distance ~400m to receptor (west). *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata): tributaries of Taurus Creek @ western side of Deep Creek landform. *Potential for AMD to reach tributaries of Taurus Creek:* ***Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach tributaries of Taurus Creek:* ***Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributaries of Taurus Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals / metalloids impacting tributaries of Taurus Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributaries of Taurus Ck [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting tributaries of Taurus Creek [via seepage]	Unlikely	S1	**Low**
	From Deep Creek spoil landform via surface water run-off into ephemeral Taurus Creek. Distance <100m to receptor (south and southwest). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): Taurus Creek @ southern and southwestern side of Deep Creek spoil landform. *Potential for AMD to reach Taurus Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Taurus Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Taurus Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Taurus Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Taurus Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Taurus Creek [via run-off]	Unlikely	S1	**Low**
	From Deep Creek spoil landform via seepage into shallow permeable strata then into ephemeral Taurus Creek. Distance <100m to receptor (south and southwest). *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata: Taurus Creek @ southern and southwestern side of Deep Creek spoil landform. *Potential for AMD to reach Taurus Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Taurus Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Taurus Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Taurus Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Taurus Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Taurus Creek [via seepage]	Unlikely	S1	**Low**

Table C5. Source-Pathway-Receptor (SPR) assessment of Stewarton spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Stewarton spoil landform (post-closure) Comprised of approximately 96% non-carbonaceous spoil; approximately 4% carbonaceous spoil; and approximately 0.2% rejects. No tailings *AMD source hazard of landform is* ***Low*** *Salinity (non-oxidative) source hazard of landform is* ***Low*** *AMD source hazard of rejects alone is* ***Moderate****. No rejects are currently in the landform. Future rejects would be broadly distributed throughout the landform and comprise a very low proportion of the landform.*	From Stewarton spoil landform via surface water run-off into ephemeral Taurus Creek. Distance <100m to receptor (north and northwest). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): Taurus Creek @ northern and northwestern side of Stewarton spoil landform. *Potential for AMD to reach Taurus Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Taurus Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Taurus Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Taurus Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Taurus Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Taurus Creek [via run-off]	Unlikely	S1	**Low**
	From Stewarton spoil landform via seepage into shallow permeable strata then into ephemeral Taurus Creek. Distance <100m to receptor (north and northwest). *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata: Taurus Creek @ northern and northwestern side of Stewarton spoil landform. *Potential for AMD to reach Taurus Creek:* ***Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Taurus Creek:* ***Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Taurus Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Taurus Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Taurus Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Taurus Creek [via seepage]	Unlikely	S1	**Low**
	From Stewarton spoil landform via surface water run-off into ephemeral Emu Creek. Distance <100m to receptor (west). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): Emu Creek @ western side of Stewarton landform. *Potential for AMD to reach Emu Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Emu Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Emu Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Emu Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Emu Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Emu Creek [via run-off]	Unlikely	S1	**Low**
	From Stewarton spoil landform via seepage into shallow permeable strata then into ephemeral Emu Creek. Distance <100m to receptor (west). *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata: Emu Creek @ western side of Stewarton spoil landform. *Potential for AMD to reach Emu Creek:* ***Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Emu Creek:* ***Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Emu Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals / metalloids impacting Emu Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Emu Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Emu Creek [via seepage]	Unlikely	S1	**Low**

Table C6. Source-Pathway-Receptor (SPR) assessment of Tannyfoil spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Tannyfoil spoil landform (post-closure) Comprised of approximately 96% non-carbonaceous spoil and approximately 4% carbonaceous spoil. No rejects or tailings *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform:* ***Low***	From Tannyfoil spoil landform via surface water run-off into ephemeral Emu Creek. Distance <100m to receptor (west). *Potential for AMD to enter surface water run-off: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off: **Unlikely***	Ephemeral creek (via surface water run-off): Emu Creek @ western side of Tannyfoil spoil landform. *Potential for AMD to reach Emu Creek: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Emu Creek: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Emu Creek [via run-off]	Highly Unlikely	S1	Low
			Neutral metalliferous drainage: Metals and metalloids impacting Emu Creek [via run-off]	Unlikely	S1	Low
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Emu Creek [via run-off]	Highly Unlikely	S1	Low
			Saline drainage (non-oxidative): Salt impacting Emu Creek [via run-off]	Unlikely	S1	Low
	From Tannyfoil spoil landform via seepage into shallow permeable strata then into ephemeral Emu Creek (and tributary). Distance <100m to receptor (west). *Potential for AMD to enter shallow groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater: **Unlikely***	Ephemeral creek (via shallow permeable strata: Emu Creek @ western side of Tannyfoil spoil landform. *Potential for AMD to reach Emu Creek: **Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Emu Creek: **Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Emu Creek [via seepage]	Highly Unlikely	S1	Low
			Neutral metalliferous drainage: Metals and metalloids impacting Emu Creek [via seepage]	Unlikely	S1	Low
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Emu Creek [via seepage]	Highly Unlikely	S1	Low
			Saline drainage (non-oxidative): Salt impacting Emu Creek [via seepage]	Unlikely	S1	Low

Table C7. Source-Pathway-Receptor (SPR) assessment of South Ballamoo (Terang) spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
South Ballamoo (Terang) spoil landform (post-closure) Comprised of approximately 95% non-carbonaceous spoil, approximately 4% carbonaceous spoil and less than 1% (approximately) rejects. No tailings. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform:* ***Low*** *AMD source hazard of rejects alone is **Moderate**. Rejects are currently in the landform at Terang pit and comprise a very low proportion of the landform. No future rejects proposed.*	From South Ballamoo (Terang) spoil landform via surface water run-off into ephemeral tributary of Sirius Creek. Distance <300m to receptor (west). *Potential for AMD to enter surface water run-off: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off: **Unlikely***	Ephemeral creek (via surface water run-off): Tributary of Sirius Creek @ western side of South Ballamoo (Terang) spoil landform. *Potential for AMD to reach Sirius Creek tributary: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Sirius Creek tributary: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Sirius Creek tributary (or Sirius Creek) [via run-off]	Highly Unlikely	S1	Low
			Neutral metalliferous drainage: Metals and metalloids impacting Sirius Creek tributary (or Sirius Creek) [via run-off]	Unlikely	S1	Low
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Sirius Creek tributary (or Sirius Creek) [via run-off]	Highly Unlikely	S1	Low
			Saline drainage (non-oxidative): Salt impacting Sirius Creek tributary (or Sirius Creek) [via run-off]	Unlikely	S1	Low
	From South Ballamoo (Terang) spoil landform via seepage into shallow permeable strata then into ephemeral tributary of Sirius Creek. Distance <300m to receptor (west). *Potential for AMD to enter shallow groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater: **Unlikely***	Ephemeral creek (via shallow permeable strata: Tributary of Sirius Creek @ western side of South Ballamoo spoil landform. *Potential for AMD to reach Sirius Creek tributary: **Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Sirius Creek tributary: **Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Sirius Creek tributary (or Sirius Creek) [via seepage]	Highly Unlikely	S1	Low
			Neutral metalliferous drainage: Metals and metalloids impacting Sirius Creek tributary (or Sirius Creek) [via seepage]	Unlikely	S1	Low
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Sirius Creek tributary (or Sirius Creek) [via seepage]	Highly Unlikely	S1	Low
			Saline drainage (non-oxidative): Salt impacting Sirius Creek tributary (or Sirius Creek) [via seepage]	Unlikely	S1	Low

Table C8. Source-Pathway-Receptor (SPR) assessment of Blackdown spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Blackdown spoil landform (post-closure) Comprised of approximately 96% non-carbonaceous spoil; approximately 4% carbonaceous spoil. No rejects or tailings *AMD source hazard of landform is* ***Low*** *Salinity (non-oxidative) source hazard of landform is* ***Low***	From Blackdown spoil landform via surface water run-off into ephemeral tributaries of Sirius Creek. Distance >500m to receptor (west). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): tributaries of Sirius Creek @ western side of Blackdown spoil landform. *Potential for AMD to reach tributaries of Sirius Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach tributaries of Sirius Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributaries of Sirius Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting tributaries of Sirius Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributaries of Sirius Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting tributaries of Sirius Creek [via run-off]	Unlikely	S1	**Low**
	From Blackdown spoil landform via seepage into shallow permeable strata then into ephemeral tributaries of Sirius Creek. Distance >500m to receptor (west). *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata: tributaries of Sirius Creek @ western side of Blackdown spoil landform. *Potential for AMD to reach tributaries of Sirius Creek:* ***Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach tributaries of Sirius Creek:* ***Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributaries of Sirius Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting tributaries of Sirius Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributaries of Sirius Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting tributaries of Sirius Creek [via seepage]	Unlikely	S1	**Low**
	From Blackdown spoil landform via surface water run-off into ephemeral tributaries of Two Mile Gully. Distance >500m to receptor (east). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): tributaries of Two Mile Gully @ eastern side of Blackdown landform. *Potential for AMD to reach tributaries of Two Mile Gully:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach tributaries of Two Mile Gully:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributaries of Two Mile Gully [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting tributaries of Two Mile Gully [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributaries of Two Mile Gully [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting tributaries of Two Mile Gully [via run-off]	Unlikely	S1	**Low**
	From Blackdown spoil landform via seepage into shallow permeable strata then into ephemeral tributaries of Two Mile Gully. Distance >500m to receptor (east). *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata: tributaries of Two Mile Gully @ eastern side of Blackdown spoil landform. *Potential for AMD to reach tributaries of Two Mile Gully:* ***Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach tributaries of Two Mile Gully:* ***Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributaries of Two Mile Gully [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals / metalloids impacting tributaries of Two Mile Gully [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributaries of Two Mile Gully [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting tributaries of Two Mile Gully [via seepage]	Unlikely	S1	**Low**

Table C9. Source-Pathway-Receptor (SPR) assessment of Kenmare spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Kenmare spoil landform (post-closure) Comprised of approximately 95% non-carbonaceous spoil; approximately 3% carbonaceous spoil; approximately 1% rejects; and approximately 1% tailings. All tailings and about half of rejects are located at Ramp 72 TSF and southern end of Kenmare pit. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform is **Low*** *AMD source hazard of Ramp 72 tailings and rejects alone is **Moderate-High to High**. This has implications for potential seepage from buried tailings and rejects within Ramp 72 TSF and Kenmare pit (**Figure 31**).* *AMD source hazard from Ramp 70 rejects alone is **Moderate.***	From Kenmare spoil landform via surface water run-off into ephemeral tributaries of Sirius Creek. Distance <100m to receptor (west / south / southwest). *Potential for AMD to enter surface water run-off: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off: **Unlikely***	Ephemeral creek (via surface water run-off): tributaries of Sirius Creek @ west / south / southwestern side of Kenmare spoil landform. *Potential for AMD to reach tributaries of Sirius Creek: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach tributaries of Sirius Creek: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributaries of Sirius Creek [via run-off]	Highly Unlikely	S2	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting tributaries of Sirius Creek [via run-off]	Unlikely	S2	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributaries of Sirius Creek [via run-off]	Highly Unlikely	S2	**Low**
			Saline drainage (non-oxidative): Salt impacting tributaries of Sirius Creek [via run-off]	Unlikely	S2	**Low**
	From Kenmare spoil landform via seepage into shallow permeable strata then into ephemeral tributaries of Sirius Creek. Distance <100m to receptor (west / south / southwest). *Potential for AMD to enter shallow groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater: **Unlikely***	Ephemeral creek (via shallow permeable strata: tributaries of Sirius Creek @ west / south / southwestern side of Kenmare spoil landform. *Potential for AMD to reach tributaries of Sirius Creek: **Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach tributaries of Sirius Creek: **Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributaries of Sirius Creek [via seepage] Risk primarily lies with seepage from buried tailings at Ramp 72 TSF and rejects within the southern end of Kenmare pit	Unlikely	S3	**Low to Medium**
			Neutral metalliferous drainage: Metals and metalloids impacting tributaries of Sirius Creek [via seepage] Risk primarily lies with seepage from buried tailings at Ramp 72 TSF and rejects within the southern end of Kenmare pit	Unlikely	S3	**Low to Medium**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributaries of Sirius Creek [via seepage] Risk primarily lies with seepage from buried tailings at Ramp 72 TSF and rejects within the southern end of Kenmare pit	Unlikely	S3	**Low to Medium**
			Saline drainage (non-oxidative): Salt impacting tributaries of Sirius Creek [via seepage] Risk primarily lies with seepage from buried tailings at Ramp 72 TSF and rejects within the southern end of Kenmare pit	Unlikely	S2	**Low**

Table C10. Source-Pathway-Receptor (SPR) assessment of Ramp 74 spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Ramp 74 (Laleham) spoil landform (post-closure) Comprised of approximately 99% non-carbonaceous spoil and approximately 1% carbonaceous spoil. No rejects or tailings. *AMD source hazard of landform is* ***Low*** *Salinity (non-oxidative) source hazard of landform:* ***Low***	From Ramp 74 spoil landform via surface water run-off into ephemeral Sirius Creek. Distance <100m to receptor (south / southwest). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): Sirius Creek @ south / southwestern side of Ramp 74 spoil landform. *Potential for AMD to reach Sirius Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Sirius Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Sirius Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Sirius Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Sirius Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Sirius Creek [via run-off]	Unlikely	S1	**Low**
	From Ramp 74 spoil landform via seepage into shallow permeable strata then into ephemeral Sirius Creek. Distance <100m to receptor (south / southwest). *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata: Sirius Creek @ south / southwestern side of Ramp 74 spoil landform. *Potential for AMD to reach Sirius Creek:* ***Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Sirius Creek:* ***Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Sirius Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Sirius Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Sirius Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Sirius Creek [via seepage]	Unlikely	S1	**Low**

Laleham TSF is within the footprint and pit shell of Ramp 74 (Laleham) spoil landform, but is conservatively assessed as a stand-alone TSF landform due to its location at the edge of the spoil landform and the concentrated nature of tailings in one area of the spoil landform (i.e. the SPR assessment of Laleham TSF has been undertaken separate to Ramp 74 spoil landform). Refer to **Table C16**.

Table C11. Source-Pathway-Receptor (SPR) assessment of Togara-North Marshmead spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Togara-North Marshmead spoil landform (post-closure) Comprised of approximately 94% non-carbonaceous spoil; approximately 6% carbonaceous spoil; and approximately 0.2% rejects. No tailings *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform is **Low*** *AMD source hazard of rejects alone is **Moderate**. Rejects are widely distributed throughout the landform and comprise a very low proportion of the landform.*	From Togara-North Marshmead spoil landform via surface water run-off into ephemeral Sirius Creek. Distance <100m to receptor (north). *Potential for AMD to enter surface water run-off: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off: **Unlikely***	Ephemeral creek (via surface water run-off): Sirius Creek @ northern side of Togara-North Marshmead spoil landform. *Potential for AMD to reach Sirius Creek: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Sirius Creek: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Sirius Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Sirius Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Sirius Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Sirius Creek [via run-off]	Unlikely	S1	**Low**
	From Togara-North Marshmead spoil landform via seepage into shallow permeable strata then into ephemeral Sirius Creek. Distance <100m to receptor (north). *Potential for AMD to enter shallow groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater: **Unlikely***	Ephemeral creek (via shallow permeable strata: Sirius Creek @ northern side of Togara-North Marshmead spoil landform. *Potential for AMD to reach Sirius Creek: **Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Sirius Creek: **Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Sirius Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Sirius Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Sirius Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Sirius Creek [via seepage]	Unlikely	S1	**Low**
	From Togara-North Marshmead spoil landform via surface water run-off into ephemeral Rockland Creek. Distance <100m to receptor (south). *Potential for AMD to enter surface water run-off: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off: **Unlikely***	Ephemeral creek (via surface water run-off): Rockland Creek @ southern side of Togara-North Marshmead spoil landform. *Potential for AMD to reach Rockland Creek: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Rockland Creek: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Rockland Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Rockland Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Rockland Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Rockland Creek [via run-off]	Unlikely	S1	**Low**
	From Togara-North Marshmead spoil landform via seepage into shallow permeable strata then into ephemeral Rockland Creek. Distance <100m to receptor (south). *Potential for AMD to enter shallow groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater: **Unlikely***	Ephemeral creek (via shallow permeable strata: Rockland Creek @ southern side of Togara-North Marshmead spoil landform. *Potential for AMD to reach Rockland Creek: **Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Rockland Creek: **Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Rockland Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Rockland Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Rockland Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Rockland Creek [via seepage]	Unlikely	S1	**Low**

Table C12. Source-Pathway-Receptor (SPR) assessment of South Marshmead spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
South Marshmead spoil landform (post-closure) Comprised of approximately 98% non-carbonaceous spoil and approximately 2% carbonaceous spoil. No rejects or tailings *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform is **Low***	From South Marshmead spoil landform via surface water run-off into ephemeral Rockland Creek. Distance <100m to receptor (north). *Potential for AMD to enter surface water run-off: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off: **Unlikely***	Ephemeral creek (via surface water run-off): Rockland Creek @ northern side of South Marshmead spoil landform. *Potential for AMD to reach Rockland Creek: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Rockland Creek: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Rockland Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Rockland Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Rockland Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Rockland Creek [via run-off]	Unlikely	S1	**Low**
	From South Marshmead spoil landform via seepage into shallow permeable strata then into ephemeral Rockland Creek. Distance <100m to receptor (north). *Potential for AMD to enter shallow groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater: **Unlikely***	Ephemeral creek (via shallow permeable strata: Rockland Creek @ northern side of South Marshmead spoil landform. *Potential for AMD to reach Rockland Creek: **Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Rockland Creek: **Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Rockland Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Rockland Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Rockland Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Rockland Creek [via seepage]	Unlikely	S1	**Low**
	From South Marshmead spoil landform via surface water run-off into ephemeral tributary of Shotover Creek. Distance ~600m to receptor (south). *Potential for AMD to enter surface water run-off: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off: **Unlikely***	Ephemeral creek (via surface water run-off): tributary of Shotover Creek @ southern side of South Marshmead spoil landform. *Potential for AMD to reach tributary of Shotover Creek: **Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach tributary of Shotover Creek: **Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributary of Shotover Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting tributary of Shotover Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributary of Shotover Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting tributary of Shotover Creek [via run-off]	Highly Unlikely	S1	**Low**
	From South Marshmead spoil landform via seepage into shallow permeable strata then into ephemeral tributary of Shotover Creek. Distance ~600m to receptor (south). *Potential for AMD to enter shallow groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater: **Unlikely***	Ephemeral creek (via shallow permeable strata: tributary of Shotover Creek @ southern side of South Marshmead spoil landform. *Potential for AMD to reach tributary of Shotover Creek: **Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach tributary of Shotover Creek: **Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting tributary of Shotover Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting tributary of Shotover Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting tributary of Shotover Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting tributary of Shotover Creek [via seepage]	Highly Unlikely	S1	**Low**

Table C13. Source-Pathway-Receptor (SPR) assessment of Kennedy spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Kennedy spoil landform (post-closure) Comprised of approximately 94% non-carbonaceous spoil and approximately 6% carbonaceous spoil. No rejects or tailings *AMD source hazard of landform is* ***Low*** *Salinity (non-oxidative) source hazard of landform:* ***Low***	From Kennedy spoil landform via surface water run-off into ephemeral Rockland Creek. Distance ~100m to receptor (west). *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): Rockland Creek @ western side of Kennedy spoil landform. *Potential for AMD to reach Rockland Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Rockland Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Rockland Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Rockland Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Rockland Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Rockland Creek [via run-off]	Unlikely	S1	**Low**
	From Kennedy spoil landform via seepage into shallow permeable strata then into ephemeral Rockland Creek. Distance ~100m to receptor (west). *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata: Rockland Creek @ western side of Kennedy spoil landform. *Potential for AMD to reach Rockland Creek:* ***Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Rockland Creek:* ***Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Rockland Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Rockland Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Rockland Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Rockland Creek [via seepage]	Unlikely	S1	**Low**

Table C14. Source-Pathway-Receptor (SPR) assessment of Comet Downs East spoil landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Comet Downs East spoil landform (post-closure) Comprised of approximately 93% non-carbonaceous spoil and approximately 7% carbonaceous spoil. No rejects or tailings *AMD source hazard of landform is* ***Low*** *Salinity (non-oxidative) source hazard of landform:* ***Low***	From Comet Downs East spoil landform via surface water run-off into ephemeral Rockland Creek. Distance ~100m to receptor (east) [and ~750m west to minor tributary]. *Potential for AMD to enter surface water run-off:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off:* ***Unlikely***	Ephemeral creek (via surface water run-off): Rockland Creek @ eastern side of Comet Downs East spoil landform [and ~750m west to minor tributary]. *Potential for AMD to reach Rockland Creek:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Rockland Creek:* ***Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Rockland Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Rockland Creek [via run-off]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Rockland Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Rockland Creek [via run-off]	Unlikely	S1	**Low**
	From Comet Downs East spoil landform via seepage into shallow permeable strata then into ephemeral Rockland Creek. Distance ~100m to receptor (east) [and ~750m west to minor tributary]. *Potential for AMD to enter shallow groundwater:* ***Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater:* ***Unlikely***	Ephemeral creek (via shallow permeable strata: Rockland Creek @ eastern side of Comet Downs East spoil landform [and ~750m west to minor tributary]. *Potential for AMD to reach Rockland Creek:* ***Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Rockland Creek:* ***Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Rockland Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Rockland Creek [via seepage]	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Rockland Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Rockland Creek [via seepage]	Unlikely	S1	**Low**

Table C15. Source-Pathway-Receptor (SPR) assessment of NCPP TSF landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
NCPP TSF landform (post-closure) (**Figure 27**) Excluding cover, the TSF is comprised of approximately 80% tailings; approximately 19% rejects; and approximately 1% fill. *AMD source hazard of landform is **Moderate-High*** *Salinity (non-oxidative) source hazard of landform is **Moderate*** TSF will have a spoil cover installed at an appropriate thickness to manage the AMD hazard of the landform. *AMD source hazard of the likely spoil cover is **Low**.*	From NCPP TSF landform via surface water run-off into ephemeral Deep Creek. Distance <100m to receptor (south / southeast). *Potential for AMD to enter surface water run-off: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off: **Unlikely***	Ephemeral creek (via surface water run-off): Deep Creek @ south / southeastern side of NCPP TSF landform. *Potential for AMD to reach Deep Creek: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Deep Creek: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Deep Creek [via run-off]	Unlikely	S2	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Deep Creek [via run-off]	Unlikely	S2	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Deep Creek [via run-off]	Unlikely	S2	**Low**
			Saline drainage (non-oxidative): Salt impacting Deep Creek [via run-off]	Unlikely	S2	**Low**
	From NCPP TSF landform via seepage into shallow permeable strata then into ephemeral Deep Creek. Distance <100m to receptor (south / southeast). *Potential for AMD to enter shallow groundwater: **Probable*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater: **Probable***	Ephemeral creek (via shallow permeable strata: Deep Creek @ south / southeastern side of NCPP TSF landform. *Potential for AMD to reach Deep Creek: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Deep Creek: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Deep Creek [via seepage]	Unlikely	S3	**Low to Medium**
			Neutral metalliferous drainage: Metals and metalloids impacting Deep Creek [via seepage]	Unlikely	S3	**Low to Medium**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Deep Creek [via seepage]	Unlikely	S3	**Low to Medium**
			Saline drainage (non-oxidative): Salt impacting Deep Creek [via seepage]	Unlikely	S2	**Low**

Table C16. Source-Pathway-Receptor (SPR) assessment of Laleham TSF landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Laleham TSF landform (post-closure) (**Figure 28**) Excluding cover, the TSF is comprised of approximately 90% tailings; approximately 4% rejects; and approximately 6% spoil/fill. *AMD source hazard of landform is **Moderate-High*** *Salinity (non-oxidative) source hazard of landform is **Moderate*** TSF will have a spoil cover installed at an appropriate thickness to manage the AMD hazard of the landform. *AMD source hazard of the likely spoil cover is **Low**.*	From Laleham TSF landform via surface water run-off into ephemeral Sirius Creek. Distance ~370m to receptor (south). *Potential for AMD to enter surface water run-off: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off: **Unlikely***	Ephemeral creek (via surface water run-off): Sirius Creek @ southern side of Laleham TSF landform. *Potential for AMD to reach Sirius Creek: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Sirius Creek: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Sirius Creek [via run-off]	Highly Unlikely	S2	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Sirius Creek [via run-off]	Highly Unlikely	S2	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Sirius Creek [via run-off]	Highly Unlikely	S2	**Low**
			Saline drainage (non-oxidative): Salt impacting Sirius Creek [via run-off]	Highly Unlikely	S2	**Low**
	From Laleham TSF landform via seepage into shallow permeable strata then into ephemeral Sirius Creek. Distance ~370m to receptor (south). *Potential for AMD to enter shallow groundwater: **Probable*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater: **Probable***	Ephemeral creek (via shallow permeable strata: Sirius Creek @ southern side of Laleham TSF landform. *Potential for AMD to reach Sirius Creek: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Sirius Creek: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Sirius Creek [via seepage]	Highly Unlikely	S2	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Sirius Creek [via seepage]	Highly Unlikely	S2	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Sirius Creek [via seepage]	Highly Unlikely	S2	**Low**
			Saline drainage (non-oxidative): Salt impacting Sirius Creek [via seepage]	Highly Unlikely	S2	**Low**

Table C17. Source-Pathway-Receptor (SPR) assessment of Bottom Dam TSF and rejects landform: surface water receptors via run-off and seepage/groundwater

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Bottom Dam TSF and rejects landform (post-closure) (**Figure 29**) The current TSF is comprised of about 95% tailings and 4% rejects. During rehabilitation, the TSF will be buried by rejects currently located adjacent to the TSF. As such, excluding spoil cover, the Bottom Dam area is estimated to be comprised of approximately 50% tailings and 50% rejects. *AMD source hazard of landform is assumed **Moderate-High*** *Salinity (non-oxidative) source hazard of landform is assumed **Moderate*** TSF/rejects area will have a spoil cover installed at an appropriate thickness to manage the AMD hazard of the landform. *AMD source hazard of the likely spoil cover is **Low**.*	From Bottom Dam TSF/rejects landform via surface water run-off into ephemeral Sirius Creek. Distance ~750m to receptor (south). *Potential for AMD to enter surface water run-off: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off: **Unlikely***	Ephemeral creek (via surface water run-off): Sirius Creek ~750 m south of Bottom Dam landform. *Potential for AMD to reach Sirius Creek: **Highly Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Sirius Creek: **Highly Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Sirius Creek [via run-off]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Sirius Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Sirius Creek [via run-off]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Sirius Creek [via run-off]	Highly Unlikely	S1	**Low**
	From Bottom Dam TSF/rejects landform via seepage into shallow permeable strata then into ephemeral Sirius Creek. Distance ~750m to receptor (south). *Potential for AMD to enter shallow groundwater: **Probable*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater: **Probable***	Ephemeral creek (via shallow permeable strata: Sirius Creek ~750 m south of Bottom Dam landform. *Potential for AMD to reach Sirius Creek: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Sirius Creek: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Sirius Creek [via seepage]	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Sirius Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Sirius Creek [via seepage]	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Sirius Creek [via seepage]	Highly Unlikely	S1	**Low**

Table C18. Source-Pathway-Receptor (SPR) assessment of Ramp 36 rejects landform: surface water receptors via run-off and via shallow permeable strata (shallow groundwater)

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Ramp 36 rejects landform (post-closure) (**Figure 30**) Excluding cover, the rejects landform is comprised of approximately 98% rejects; and approximately 2% fill. No tailings. *AMD source hazard of landform is **Moderate-High*** *Salinity (non-oxidative) source hazard of landform is **Moderate*** Rejects dump will have a spoil cover installed at an appropriate thickness to manage the AMD hazard of the landform. *AMD source hazard of the likely spoil cover is **Low**.*	From Ramp 36 rejects landform via surface water run-off into ephemeral Deep Creek. Distance <100m to receptor (north / northeast). *Potential for AMD to enter surface water run-off: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off: **Unlikely***	Ephemeral creek (via surface water run-off): Deep Creek @ north / northwestern side of Ramp 36 rejects landform. *Potential for AMD to reach Deep Creek: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Deep Creek: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Deep Creek [via run-off]	Unlikely	S2	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Deep Creek [via run-off]	Unlikely	S2	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Deep Creek [via run-off]	Unlikely	S2	**Low**
			Saline drainage (non-oxidative): Salt impacting Deep Creek [via run-off]	Unlikely	S2	**Low**
	From Ramp 36 rejects landform via seepage into shallow permeable strata then into ephemeral Deep Creek. Distance <100m to receptor (north / northwest). *Potential for AMD to enter shallow groundwater: **Probable*** *Potential for salt (non-oxidative) >900 µS/cm to enter shallow groundwater: **Probable***	Ephemeral creek (via shallow permeable strata: Deep Creek @ south / southeastern side of Ramp 36 rejects landform. *Potential for AMD to reach Deep Creek: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach Deep Creek: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Deep Creek [via seepage]	Unlikely	S3	**Low to Medium**
			Neutral metalliferous drainage: Metals and metalloids impacting Deep Creek [via seepage]	Unlikely	S2	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Deep Creek [via seepage]	Unlikely	S3	**Low to Medium**
			Saline drainage (non-oxidative): Salt impacting Deep Creek [via seepage]	Unlikely	S2	**Low**

Table C19. Source-Pathway-Receptor (SPR) assessment of Ramp 8, Bonnie Doon, Mimosa-Besgrove and Deep Creek spoil landforms: residual void receptors

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Ramp 8 spoil landform Comprised of approximately 96% non-carbonaceous spoil and approximately 4% carbonaceous spoil. No rejects or tailings. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform: **Low***	Seepage / percolation from Ramp 8 spoil landform into groundwater, which flows into Ramp 8 residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	Ramp 8 residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Ramp 8 residual void water quality	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Ramp 8 residual void water quality	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Ramp 8 residual void water quality	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Ramp 8 residual void water quality	Unlikely	S1	**Low**
Bonnie Doon (BD) spoil landform (post-closure) Comprised of approximately 96% non-carbonaceous spoil and approximately 4% carbonaceous spoil. No rejects or tailings. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform: **Low***	Seepage / percolation from BD spoil landform into groundwater, which flows into neighbouring Ramp 8 (R8) and Mimosa-Besgrove (MB) residual voids. Voids are expected to intersect the water table. Voids are groundwater 'sinks', drawing all groundwater within the void groundwater catchment towards these two residual voids. Groundwater seeping towards BD void will ultimately flow into R8 and MB voids, due to these two voids being much deeper than BD void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	Ramp 8 and Mimosa-Besgrove residual voids (NUMAs). *Potential for AMD to reach residual voids: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual voids: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Ramp 8 and/or Mimosa-Besgrove residual void water quality	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Ramp 8 and/or Mimosa-Besgrove residual void water quality	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Ramp 8 and/or Mimosa-Besgrove residual void water quality	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Ramp 8 and/or Mimosa-Besgrove void water quality	Unlikely	S1	**Low**
Mimosa-Besgrove spoil landform (post-closure) Comprised of approx. 95% non-carb. spoil; approx. 2.9% carb. spoil; and approx. 1.9% rejects. No tailings. *AMD source hazard of landform is **Low** Salinity (non-oxidative) source hazard of landform is **Low*** *Rejects concentrated at R32 rejects dump, <100m from edge of spoil landform. AMD source hazard of rejects is **Moderate***	Seepage / percolation from Mimosa-Besgrove spoil landform into groundwater, which flows into Mimosa-Besgrove residual void (+/- Ramp 30S residual void). Residual voids are expected to intersect the water table. Residual voids are a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	Mimosa-Besgrove and Ramp 30S residual voids (NUMAs) *Potential for AMD to reach residual voids: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual voids: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Mimosa-Besgrove or Ramp 30S residual void water quality	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Mimosa-Besgrove or Ramp 30S residual void water quality	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Mimosa-Besgrove or Ramp 30S residual void water quality	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Mimosa-Besgrove or Ramp 30S residual void water quality	Unlikely	S1	**Low**
Deep Creek spoil landform (post-closure) Comprised of approx. 96% non-carb. spoil; approx. 3% carb. spoil; and approx. 1% rejects. No tailings. *AMD source hazard of landform is **Low** Salinity (non-oxidative) source hazard of landform is **Low*** *AMD source hazard of rejects alone is **Moderate**. Rejects are distributed throughout the landform.*	Seepage / percolation from Deep Creek spoil landform into groundwater, which flows into Deep Creek residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	Deep Creek residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Deep Creek residual void water quality	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Deep Creek residual void water quality	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Deep Creek residual void water quality	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Deep Creek residual void water quality	Unlikely	S1	**Low**

Table C20. Source-Pathway-Receptor (SPR) assessment of Stewarton, Tannyfoil, Blackdown and South Ballamoo (Terang) spoil landforms: residual void receptors

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Stewarton spoil landform Comprised of approximately 96% non-carbonaceous spoil and approximately 4% carbonaceous spoil. No rejects or tailings. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform: **Low***	Seepage / percolation from Stewarton spoil landform into groundwater, which flows into Stewarton North residual void (+/- via Stewarton South void, which is approximately half the depth of Stewarton North void). Stewarton North residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment (including from Stewarton South void) towards the residual void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	Stewarton North residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Stewarton North residual void water quality	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Stewarton North residual void water quality	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Stewarton North residual void water quality	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Stewarton North residual void water quality	Unlikely	S1	**Low**
Tannyfoil spoil landform (post-closure) Comprised of approximately 96% non-carbonaceous spoil and approximately 4% carbonaceous spoil. No rejects or tailings. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform: **Low***	Seepage / percolation from Tannyfoil spoil landform into groundwater, which flows into Tannyfoil residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	Tannyfoil residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Tannyfoil residual void water quality	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Tannyfoil residual void water quality	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Tannyfoil residual void water quality	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Tannyfoil void water quality	Unlikely	S1	**Low**
Blackdown spoil landform (post-closure) Comprised of approximately 96% non-carbonaceous spoil and approximately 4% carbonaceous spoil. No rejects or tailings. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform: **Low***	Seepage / percolation from Blackdown spoil landform into groundwater, which flows into Tannyfoil and South Ballamoo residual voids. Residual voids are expected to intersect the water table. Residual voids are a groundwater 'sink', drawing all groundwater within the voids' groundwater catchment towards the residual voids. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	Tannyfoil and South Ballamoo residual voids (NUMA). *Potential for AMD to reach residual voids: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual voids: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Tannyfoil and South Ballamoo residual voids' water quality	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Tannyfoil and South Ballamoo residual voids' water quality	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Tannyfoil and South Ballamoo residual voids' water quality	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Tannyfoil and South Ballamoo residual voids' water quality	Unlikely	S1	**Low**
South Ballamoo (Terang) spoil landform (post-closure) Comprised of approx. 95% non-carb. spoil; approx. 4% carb. spoil; and approx. 1% rejects. No tailings. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform is **Low*** *AMD source hazard of rejects alone is **Moderate**. Rejects are located at Ramp 64 (northern end of existing Terang pit).*	Seepage / percolation from South Ballmoo (Terang) spoil landform into groundwater, which flows into South Ballamoo residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	South Ballamoo residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting South Ballamoo residual void water quality	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting South Ballamoo residual void water quality	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting South Ballamoo residual void water quality	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting South Ballamoo residual void water quality	Unlikely	S1	**Low**

Table C21. Source-Pathway-Receptor (SPR) assessment of Kenmare, Ramp 74 and Togara-North Marshmead spoil landforms: residual void receptors

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Kenmare spoil landform (post-closure) Comprised of approximately 95% non-carbonaceous spoil; approximately 3% carbonaceous spoil; approximately 1% rejects; and approximately 1% tailings. *AMD source hazard of landform is **Low**.* *Salinity (non-oxidative) source hazard of landform is **Low**.* All tailings and about half of rejects are located at R72 TSF and southern end of Kenmare pit. *AMD source hazard of R72 tailings and rejects is **Moderate-High to High**.* *AMD source hazard of R70 rejects is **Moderate***	Seepage / percolation from Kenmare spoil landform into groundwater, which flows into Kenmare residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	Kenmare residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Kenmare residual void water quality	Highly Unlikely	S1	Low
			Neutral metalliferous drainage: Metals and metalloids impacting Kenmare residual void water quality	Unlikely	S1	Low
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Kenmare residual void water quality	Highly Unlikely	S1	Low
			Saline drainage (non-oxidative): Salt impacting Kenmare void water quality	Unlikely	S1	Low
Ramp 74 (Laleham) spoil landform (post-closure) Comprised of approximately 99% non-carbonaceous spoil and approximately 1% carbonaceous spoil. No rejects or tailings. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform: **Low***	Seepage / percolation from Ramp 74 spoil landform into groundwater, which flows into Togara-North Marshmead residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	Togara-North Marshmead residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Togara-Nth Marshmead residual void water quality	Highly Unlikely	S1	Low
			Neutral metalliferous drainage: Metals and metalloids impacting Togara-Nth Marshmead residual void water quality	Unlikely	S1	Low
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Togara-Nth Marshmead residual void water quality	Highly Unlikely	S1	Low
			Saline drainage (non-oxidative): Salt impacting Togara-Nth Marshmead residual void water quality	Unlikely	S1	Low
Togara-North Marshmead spoil landform (post-closure) Comprised of approximately 94% non-carbonaceous spoil; approximately 6% carbonaceous spoil; and approximately 0.2% rejects. No tailings. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform is **Low*** *AMD source hazard of rejects alone is **Moderate**.* *Rejects are distributed throughout the landform.*	Seepage / percolation from Togara-North Marshmead spoil landform into groundwater, which flows into Togara-North Marshmead residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	Togara-North Marshmead residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Togara-Nth Marshmead residual void water quality	Highly Unlikely	S1	Low
			Neutral metalliferous drainage: Metals and metalloids impacting Togara-Nth Marshmead residual void water quality	Unlikely	S1	Low
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Togara-Nth Marshmead residual void water quality	Highly Unlikely	S1	Low
			Saline drainage (non-oxidative): Salt impacting Togara-Nth Marshmead residual void water quality	Unlikely	S1	Low

Table C22. Source-Pathway-Receptor (SPR) assessment of South Marshmead, Kennedy and Comet Downs East spoil landforms: residual void receptors

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
South Marshmead spoil landform (post-closure) Comprised of approximately 98% non-carbonaceous spoil and approximately 2% carbonaceous spoil. No rejects or tailings. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform is **Low***	Seepage / percolation from South Marshmead spoil landform into groundwater, which flows into South Marshmead residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	South Marshmead residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting South Marshmead residual void water quality	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting South Marshmead residual void water quality	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting South Marshmead residual void water quality	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting South Marshmead residual void water quality	Unlikely	S1	**Low**
Kennedy spoil landform (post-closure) Comprised of approximately 94% non-carbonaceous spoil and approximately 6% carbonaceous spoil. No rejects or tailings. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform is **Low***	Seepage / percolation from Kennedy spoil landform into groundwater, which flows into Kennedy residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	Kennedy West residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Kennedy West residual void water quality	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Kennedy West residual void water quality	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Kennedy West residual void water quality	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Kennedy West void water quality	Unlikely	S1	**Low**
Comet Downs East spoil landform (post-closure) Comprised of approximately 93% non-carbonaceous spoil and approximately 7% carbonaceous spoil. No rejects or tailings. *AMD source hazard of landform is **Low*** *Salinity (non-oxidative) source hazard of landform is **Low***	Seepage / percolation from Comet Downs East spoil landform into groundwater, which flows into Comet Downs East residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Unlikely***	Comet Downs East residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Comet Downs East residual void water quality	Highly Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Comet Downs East residual void water quality	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Comet Downs East residual void water quality	Highly Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting Comet Downs East residual void water quality	Unlikely	S1	**Low**

Table C23. Source-Pathway-Receptor (SPR) assessment of post-closure TSF and rejects landforms: residual void receptors

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
NCPP TSF landform (post-closure) Excluding cover, the TSF is comprised of approx. 80% tailings, approx. 19% rejects, and approx. 1% fill. *AMD source hazard of landform is **Moderate-High**. Salinity (non-oxidative) source hazard of landform is **Moderate**.* TSF will have a spoil cover installed at an appropriate thickness to manage the AMD hazard of the landform. *Assume AMD source hazard of the spoil cover is **Low-Moderate***	Seepage / percolation from NCPP TSF landform into groundwater, which flows into Deep Creek residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Probable*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Probable***	Deep Creek residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Deep Creek residual void water quality	Unlikely	S2	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Deep Creek residual void water quality	Unlikely	S2	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Deep Creek residual void water quality	Unlikely	S2	**Low**
			Saline drainage (non-oxidative): Salt impacting Deep Creek residual void water quality	Unlikely	S2	**Low**
Laleham TSF landform (post-closure) Excluding cover, the TSF is comprised of approx. 90% tailings, approx. 4% rejects, and approx. 6% spoil/fill. *AMD source hazard of landform is **Moderate-High**. Salinity (non-oxidative) source hazard of landform is **Moderate**.* TSF will have a spoil cover installed at an appropriate thickness to manage the AMD hazard of the landform. *AMD source hazard of the likely spoil cover is **Low-Moderate**.*	Seepage / percolation from Laleham TSF landform into groundwater, which flows into Togara-North Marshmead residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Probable*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Probable***	Togara-North Marshmead residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Togara-Nth Marshmead residual void water quality	Unlikely	S2	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Togara-Nth Marshmead residual void water quality	Unlikely	S2	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Togara-Nth Marshmead residual void water quality	Unlikely	S2	**Low**
			Saline drainage (non-oxidative): Salt impacting Togara-Nth Marshmead void water quality	Unlikely	S2	**Low**
Bottom Dam TSF and rejects landform (post-closure) The current TSF is comprised of about 95% tailings and 4% rejects. During rehabilitation, the TSF will be buried by rejects currently located adjacent to the TSF. As such, excluding spoil cover, the Bottom Dam area is estimated to be comprised of approximately 50% tailings and 50% rejects. *AMD source hazard of landform is assumed **Moderate-High**. Salinity (non-oxidative) source hazard of landform is assumed **Moderate*** TSF/rejects area will have a spoil cover installed at an appropriate thickness to manage the AMD hazard of the landform. *AMD source hazard of the likely spoil cover is **Low**.*	Seepage / percolation from Bottom Dam TSF/rejects landform into groundwater, which flows into Togara-North Marshmead residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Probable*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Probable***	Togara-North Marshmead residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Togara-Nth Marshmead residual void water quality	Unlikely	S2	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Togara-Nth Marshmead residual void water quality	Unlikely	S2	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Togara-Nth Marshmead residual void water quality	Unlikely	S2	**Low**
			Saline drainage (non-oxidative): Salt impacting Togara-Nth Marshmead void water quality	Unlikely	S2	**Low**
Ramp 36 rejects landform (post-closure) Excluding cover, the rejects landform is comprised of approx. 99% rejects and 1% fill. No tailings. *AMD source hazard of landform is **Moderate**. Salinity (non-oxidative) source hazard of landform is **Moderate**.* Rejects dump will have a spoil cover installed at an appropriate thickness to manage the AMD hazard of the landform. *AMD source hazard of the likely spoil cover is **Low-Moderate**.*	Seepage / percolation from Ramp 36 rejects landform into groundwater, which flows into Deep Creek residual void. Residual void is expected to intersect the water table. Residual void is a groundwater 'sink', drawing all groundwater within the void groundwater catchment towards the residual void. *Potential for AMD to enter groundwater: **Probable*** *Potential for salt (non-oxidative) >900 µS/cm to enter groundwater: **Probable***	Deep Creek residual void (NUMA). *Potential for AMD to reach residual void: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual void: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Deep Creek residual void water quality	Unlikely	S2	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Deep Creek residual void water quality	Unlikely	S2	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Deep Creek residual void water quality	Unlikely	S2	**Low**
			Saline drainage (non-oxidative): Salt impacting Deep Creek residual void water quality	Unlikely	S2	**Low**

Table C24. Source-Pathway-Receptor (SPR) assessment of residual void walls and floor: residual void receptors

Source	Pathway	Receptor	Event / potential harm	Likelihood of Event	Severity of Event	Risk Rating
Floor (tailings) and walls of Bonnie Doon and Ramp 74 residual voids (post-closure) Walls of these two voids are comprised of approximately: • 90% to 93% non-carbonaceous overburden/interburden; • <1% to 4% carbonaceous overburden/interburden; • 6% to 7% coal (residual coal seams). 'PAF' and NAF-S exposure on Bonnie Doon and Ramp 74 void walls conservatively estimated at approximately 4% (vertical meterage). A proportion of this will be in lower seams, which will be buried by tailings and/or submerged. 'PAF' or NAF-S exposure on pit floors (tailings) conservatively estimated at approximately 46% (Bonnie Doon) and 72% (Ramp 74), however tailings will be submerged or capped/covered. *AMD source hazard from exposed walls is **Low**.* *AMD source hazard from submerged or covered/capped tailings floor is **Moderate to Moderate-High**.* *Salinity (non-oxidative) source hazard of the exposed walls and submerged or covered/capped tailings floor is **Moderate**.*	Surface water run-off from highwalls of Bonnie Doon and Ramp 74 voids into their respective residual voids. *Potential for AMD to enter surface water run-off from void walls: **Probable*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off from void walls: **Probable***	Bonnie Doon and Ramp 74 residual voids (NUMA). *Potential for AMD to reach residual voids: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual voids: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting Bonnie Doon residual void water quality Low pH and metalliferous water impacting Ramp 74 residual void water quality	Unlikely	S2	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting Bonnie Doon residual void water quality Metals and metalloids impacting Ramp 74 residual void water quality	Unlikely	S2	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting Bonnie Doon residual void water quality Salt (sulfate) impacting Ramp 74 residual void water quality	Unlikely	S2	**Low**
			Saline drainage (non-oxidative): Salt impacting Bonnie Doon residual void water quality Salt impacting Ramp 74 residual void water quality	Unlikely	S2	**Low**
Floor (coal) and walls of all residual voids except Bonnie Doon and Ramp 74 voids (post-closure) Walls of all non-tailings voids are comprised of approximately: • 87% to 95% non-carbonaceous overburden/interburden; • 1.2% to 6% carbonaceous overburden/interburden; • 2% to 7% coal (residual coal seams). 'PAF' and NAF-S exposure on walls conservatively estimated at between 3.6% to 6% (vertical meterage). A proportion of this will be in lower seams, which will be submerged. 'PAF' or NAF-S exposure on pit floors (coal) conservatively estimated at less than 5%, however pit floors will be submerged. *AMD source hazard from exposed walls is **Low**.* *AMD source hazard from submerged pit floors is **Low**.* *Salinity (non-oxidative) source hazard of the exposed walls and submerged pit floors is **Moderate**.*	Surface water run-off from walls of residual voids into residual voids. *Potential for AMD to enter surface water run-off from void walls: **Probable*** *Potential for salt (non-oxidative) >900 µS/cm to enter surface water run-off from void walls: **Probable***	All residual voids (NUMA). *Potential for AMD to reach residual voids: **Unlikely*** *Potential for salt (non-oxidative) >900 µS/cm to reach residual voids: **Unlikely***	**Acid/acidic drainage:** Low pH and metalliferous water impacting residual void water quality	Unlikely	S1	**Low**
			Neutral metalliferous drainage: Metals and metalloids impacting residual void water quality	Unlikely	S1	**Low**
			Saline drainage (from sulfide oxidation): Salt (sulfate) impacting residual void water quality	Unlikely	S1	**Low**
			Saline drainage (non-oxidative): Salt impacting residual void water quality	Unlikely	S1	**Low**

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