Permit

Environmental Protection Act 1994

Environmental Authority EA0002465

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

Environmental authority number: EA0002465

Environmental authority takes effect on 2 February 2023

Environmental authority holder(s)

Name(s)	Registered address
COKING COAL ONE PTY LTD	4/167 Eagle Street, Brisbane City, QLD 4000

Environmentally relevant activity and location details

Environmentally relevant activity/activities	Location(s)
Resource Activity, Schedule 3, 13: Mining black coal	ML70257
Resource Activity, Schedule 3, 09: A mining activity involving drilling, costeaning, pitting or carrying out geological surveys causing significant disturbance.	
Ancillary Activity, Schedule 2, 60(1): Operating a facility for disposing of, in a year, the following quantity of waste mentioned in subsection 1(a)—(d) more than 200,000t.	
Ancillary Activity, Schedule 2, 60(2): Operating a facility for disposing of, in a year, the following quantity of waste mentioned in subsection (1)(b)—(c) more than 5,000t but not more than 10,000t.	

Additional information for applicants

<u>Environmentally relevant activities</u>

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

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

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

Contaminated land

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

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

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

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

Take effect

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

a) if the authority is for a prescribed ERA and it states that it takes effect on the day nominated by the holder of the authority in a written notice given to the administering authority-on the nominated day; or

b) if the authority states a day or an event for it to take effect-on the stated day or when the stated event happens; or

c) otherwise- one the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Planning Act 2016* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

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

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

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

Date Issued: 2 February 2023

Enquiries:
Business Centre (Coal)
Department of Environment and Science
PO Box 3028
EMERALD QLD 4720
Phone: (07) 4987 9320
Email: CRMining@des.qld.gov.au

Obligations under the *Environmental Protection Act 1994*

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

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

Other permits required

This permit only provides an approval under the *Environmental Protection Act 1994*. In order to lawfully operate you may also require permits / approvals from your local government authority, other business units within the department and other State Government agencies prior to commencing any activity at the site. For example, this may include permits / approvals with your local Council (for planning approval), the Department of Transport and Main Roads (to access state controlled roads), the Department of Natural Resources, Mines and Energy (to clear vegetation), and the Department of Agriculture and Fisheries (to clear marine plants or to obtain a quarry material allocation).

Obligations under the *Mining and Quarrying Safety and Health Act 1999*

If you are operating a quarry, other than a sand and gravel quarry where there is no crushing capability, you will be required to comply with the *Mining and Quarrying Safety and Health Act 1999*. For more information on your obligations under this legislation contact Mine Safety and Health at www.dnrme.qld.gov.au, or phone 13 QGOV (13 74 68) or your local Mines Inspectorate Office.

Development Approval

This permit is not a development approval under the *Planning Act 2016*. The conditions of this environmental authority are separate, and in addition to, any conditions that may be on the development approval. If a copy of this environmental authority is attached to a development approval, it is for information only, and may not be current. Please contact the Department of Environment and Science to ensure that you have the most current version of the environmental authority relating to this site.

Conditions of environmental authority

The environmentally relevant activity(ies) conducted at the location as described above must be conducted in accordance with the following site-specific conditions of approval. This environmental authority consists of the following Schedules and Appendices:

Schedule A	General
Schedule B	Air
Schedule C	Surface Water
Schedule D	Ground Water
Schedule E	Acoustic
Schedule F	Waste
Schedule G	Land
Schedule H	Regulated Structures

Conditions of environmental authority

Schedule A: General	
Condition number	**Condition**
A1	This environmental authority authorises environmental harm referred to in the conditions. Where there is no condition or this environmental authority is silent on a matter, the lack of a condition or silence does not authorise environmental harm.
A2	**Authorised activities** In carrying out the mining activity authorised by this environmental authority, disturbance of land: a) is authorised in the areas marked 'A' as depicted in **Figure 1 - Disturbance Map**; b) is not authorised in the areas marked 'B' as depicted in **Figure 1 - Disturbance Map**; and c) is only authorised in the areas marked 'C' as depicted in **Figure 1 - Disturbance Map** in accordance with **Conditions A3** and **A4**; and d) is limited to the historic boreholes in the areas marked 'D' as depicted in **Figure 1 - Disturbance Map,** and new disturbance is not authorised.
A3	Significant residual impacts to prescribed environmental matters are not authorised under this environmental authority or the *Environmental Offsets Act 2014.*
A4	Records demonstrating that each impact to a prescribed environmental matter did not, or is not likely to, result in a significant residual impact to that matter must be: a) completed by an appropriately qualified person; and b) kept for the life of the environmental authority.
A5	**Scope of activity** This environmental authority authorises the mining of up to **1.9 million tonnes** of run of mine (ROM) coal per annum (mtpa).
A6	**Maintenance of measures, plant and equipment** The environmental authority holder must ensure: a) that all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority are installed; b) that such measures, plant and equipment are maintained in a proper condition; and c) that such measures, plant and equipment are operated in a proper manner.
A7	**Storage and handling of flammable and combustible liquids** Spillage of all flammable and combustible liquids must be contained within an on-site containment system and controlled in a manner that prevents environmental harm (other than trivial harm) and maintained in accordance with Section 5.8 of AS 1940 - *Storage and Handling of Flammable and Combustible Liquids of 2004*.

A8	**Monitoring and records** Record, compile and keep for a minimum of **five (5) years** all monitoring results required by this environmental authority and make available for inspection all or any of these records upon request by the administering authority.
A9	Monitoring and determinations required under any condition of this environmental authority must be conducted by an appropriately qualified person(s).
A10	**Management Plans and Reports** Management plans and reports required under any condition of this environmental authority must be developed by an appropriately qualified person.
A11	All records, reports, management plans, programs and compliance monitoring results required by this environmental authority, must be made available to the administering authority within **five (5) business days** of the administering authority's request.
A12	The holder of this environmental authority must, when requested by the administering authority, undertake relevant specified monitoring within a reasonable timeframe nominated or agreed to by the administering authority to investigate any complaint of environmental harm. The results of the investigation (including an analysis and interpretation of the monitoring results) and abatement measures, where implemented, must be provided to the administering authority within **10 business days** of completion of the investigation, or no later than **10 business days** after the end of the timeframe nominated by the administering authority to undertake the investigation.
A13	**Notification of emergencies, incidents and exceptions** All reasonable actions are to be taken to minimise environmental harm, or potential environmental harm, resulting from any emergency, incident or circumstances not in accordance with the conditions of this environmental authority.
A14	The holder of this environmental authority must notify the administering authority by written notification within **24 hours**, after becoming aware of any emergency or incident which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with, the conditions of this environmental authority.
A15	The notification of emergencies or incidents as required by **Condition A15** of this environmental authority must include, but not be limited to, the following: a) the holder of the environmental authority; b) the location of the emergency or incident; c) the number of the environmental authority; d) the name and telephone number of the designated contact person; e) the time of the release; f) the time the holder of the environmental authority became aware of the release; g) the suspected cause of the release; h) the environmental harm caused, threatened, or suspected to be caused by the release; and i) actions taken to prevent any further release and mitigate any environmental harm caused by the release.

A16	Within **10 business days** following the initial notification of an emergency or incident, or receipt of monitoring results, whichever is the latter, further written advice must be provided to the administering authority, including the following: a) results and interpretation of any samples taken and analysed; b) outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; and c) proposed actions to prevent a recurrence of the emergency or incident.
A17	As soon as practicable, but not more than **six (6) weeks** following the conduct of any environmental monitoring performed in relation to the emergency or incident, which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with the conditions of this environmental authority, written advice must be provided of the results of any such monitoring performed to the administering authority.
A18	**Exploration activities** Exploration activities must be undertaken in accordance with the conditions contained in the *Eligibility criteria and standard conditions for exploration and mineral development projects* (ESR/2016/1985).
A19	**Complaint Response** All complaints received must be recorded including details of complainant, reasons for the complaint, investigations undertaken, conclusions formed, and actions taken. This information must be made available for inspection by the administering authority on request.
A20	**Third-party reporting** The holder of this environmental authority must: a) within **one (1) year** of the commencement of this environmental authority, obtain from an appropriately qualified person a report on compliance with the conditions of this environmental authority; b) obtain further such reports at regular intervals, not exceeding **three-yearly** intervals, from the completion of the report referred to above; and c) provide each report to the administering authority within **90 days** of its completion.
A21	Where a condition of this environmental authority requires compliance with a standard, policy or guideline published externally to this environmental authority and the standard is amended or changed subsequent to the issue of this environmental authority, the holder of this environmental authority must: a) comply with the amended or changed standard, policy, or guideline within two years of the amendment or change being made, unless a different period is specified in the amended standard or relevant legislation, or where the amendment or change relates specifically to regulated structures referred to in Schedule G, the time specified in that condition; and b) until compliance with the amended or changed standard, policy or guideline is achieved, continue to remain in compliance with the corresponding provision that was current immediately prior to the relevant amendment or change.

Schedule B: Air	
Condition number	**Condition**
B1	**Dust nuisance** The release of dust and/or particulate matter resulting from the mining activity must not cause an environmental nuisance to an environmental value for air.
B2	Dust and particulate matter emissions generated by the authorised mining activities must not exceed the following levels when measured at any area or place at which an air quality objective applies: a) Dust deposition of 120 milligrams per square metre per day, averaged over **one (1) month**, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 *Methods for sampling and analysis of ambient air—Determination of particulate matter—Deposited matter – Gravimetric method*. b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a **24-hour** averaging time, monitored in accordance with the most recent version of either: i. Australian Standard AS3580.9.6 *Methods for sampling and analysis of ambient air—Determination of suspended particulate matter— PM_{10} high volume sampler with size-selective inlet – Gravimetric method*; or ii. Australian Standard AS3580.9.9 *Methods for sampling and analysis of ambient air—Determination of suspended particulate matter— PM_{10} low volume sampler—Gravimetric method*; or iii. Australian Standard AS3580.9.11 *Methods for sampling and analysis of ambient air—Determination of suspended particulate matter— PM_{10} beta attenuation monitors or* c) A concentration of particulate matter with an aerodynamic diameter of less than 2.5 micrometres (PM2.5) suspended in the atmosphere of 25 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version either of AS/NZS3580.9.10 *Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM (sub)2.5(/sub) low volume sampler—Gravimetric method* or AS/NZS3580.9.12 (2013): *Determination of suspended particulate matter – PM2.5 beta attenuation monitors*.
B3	An Air Quality Monitoring and Management Plan must be developed and implemented within **12 months** of the commencement of mining activities and be made available to the administering authority upon request.

B4	The Air Quality Monitoring and Management Plan, as required by **Condition B3,** must include but not be limited to – a) an air quality monitoring program for PM10, PM2.5 and dust deposition showing: • air quality monitoring locations and frequency; • selection criteria for nominated air quality monitoring locations; • air quality monitoring parameters and limits; • details of monitoring equipment and methodology/standards followed for air quality monitoring; • details of at least one meteorological station capable of monitoring wind direction and speed; b) a Trigger Action Response Plan; c) a complaint response plan; and d) a requirement for review and update.
B5	If the monitoring indicates an exceedance of the relevant limits in **Condition B2**, then an investigation must be undertaken to determine whether the exceedance is due to emissions from the mining activity. If the authorised mining activities are found to be the cause of the exceedance, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement dust abatement measures so that emissions of dust from the activity does not result in further environmental nuisance.

Schedule C: Water	
Condition number	**Condition**
C1	**Contaminant Release** Contaminants that will or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of the authorised mining activities, except as permitted under the conditions of this environmental authority.
C2	Unless otherwise permitted under the conditions of this environmental authority, the release of mine affected water to waters must only occur from the release point specified in **Table C1 - Mine Affected Water Release Points, Sources and Receiving Waters** and depicted in **Figure 3 – Mine affected water release points and monitoring locations.**
C3	The release of mine affected water to waters in accordance with **Condition C2** must meet the sediment load concentration measured as Total Suspended Solids (mg/L) stated in **Table C2 - Contaminant Release Limits** for each release.

Table C1- Mine Affected Water Release Points, Sources and Receiving Waters

Release Point (RP)	Easting (GDA20)	Northing GDA20)	Mine Affected Water Source and Location	Monitoring Point	Receiving Waters Description
RP 1	619279	7587480	Mine affected water – MWD1 and North Pit	MP2	Hat Creek

C4	The release of mine affected water to internal water management infrastructure that is installed and operated in accordance with a Water Management Plan that complies with **Conditions C30** and **C31** is permitted.
C5	The release of mine affected water to waters in accordance with **Condition C2** must not exceed the release limits stated in **Table C2 - Contaminant Release Limits** when measured at the monitoring points specified in **Table C1 - Mine Affected Water Release Points, Sources and Receiving Waters** for each quality characteristic.
C6	The release of mine affected water to waters from the release point must be monitored at the locations specified in **Table C1 - Mine Affected Water Release Points, Sources and Receiving Waters** for each quality characteristic and at the frequency specified in **Table C2 – Contaminant Release Limits** and trigger investigation levels specified in **Table C3 - Release Contaminant Trigger Investigation Levels – Potential Contaminants**. NOTE: *The administering authority will take into consideration any extenuating circumstances prior to determining an appropriate enforcement response in the event **Condition C5** is contravened due to a temporary lack of safe or practical access. The administering authority expects the environmental authority holder to take all reasonable and practicable measures to maintain safe and practical access to designated monitoring locations.*

Table C2 - Contaminant Release Limits

Quality Characteristic	Release Limits	Monitoring frequency	Comment
Electrical conductivity (µS/cm)	baseflow: 720 µS/cm high flow: 250 µS/cm	Daily during release (the first sample must be taken within two (2) hours of commencement of release)	
pH (pH Unit)	6.5 (minimum) 8.5 (maximum)	Daily during release (the first sample must be taken within two (2) hours of commencement of release)	
Turbidity (NTU)	50	Daily during release (the first sample must be taken within two (2) hours of commencement of release)	Turbidity is required to assess ecosystems impact and can provide instantaneous results.
Total Suspended Solids (mg/L)	55	At commencement and prior to cessation of release (at a minimum) and weekly during a release [1]	Suspended solids are required to measure the performance of sediment and erosion control measures.
Sulphate (mg/L)	25	At commencement and prior to cessation of release (at a minimum) and weekly during a release [1]	

NOTE*: [1] The determination of suitability for release of water should be informed by monitoring undertaken prior to release.*

Table C3 - Release Contaminant Trigger Investigation Levels – Potential Contaminants

Quality Characteristic	Trigger Levels	Comment on Trigger Level	Monitoring Frequency
Total Suspended Solids	55 (mg/L)	*For aquatic ecosystem protection, based on SMD Isaac River Sub-basin Environmental Values and Water Quality Objectives.*	Commencement of release and thereafter weekly during release
Total Dissolved Solids	4000 (mg/L)	*For aquatic ecosystem protection, based on SMD Isaac River Sub-basin Environmental Values and Water Quality Objectives.*	
Sulfate	<25 (mg/L)	*For aquatic ecosystem moderately disturbed, within Upper Isaac River catchment waters, based Isaac River Sub-basin Environmental Values and Water Quality Objectives 2011.*	
Aluminium	55 (µg/L)	*For aquatic ecosystem protection, based on SMD Isaac River Sub-basin Environmental Values and Water Quality Objectives.*	
Arsenic (As V)	13 (µg/L)	*For aquatic ecosystem protection, based on SMD guideline*	
Boron	940 (µg/L)	*For aquatic ecosystem protection, based on SMD guideline*	
Cadmium	0.2 (µg/L)	*For aquatic ecosystem protection, based on SMD guideline*	
Fluoride	2000 (µg/L)	*ANZECC stock water drinking guideline.*	
Lead	3.4 (µg/L)	*For aquatic ecosystem protection, based on SMD guideline*	
Manganese	1900 (µg/L)	*For aquatic ecosystem protection, based on SMD guideline*	
Mercury (inorganic)	0.06 (µg/L)	*For aquatic ecosystem protection, based on SMD guideline*	
Molybdenum	150 (µg/L)	*ANZECC stock water drinking guideline*	
Nickel	11 (µg/L)	*For aquatic ecosystem protection, based on SMD guideline*	
Chromium	1.0 (µg/L)	*For aquatic ecosystem protection, based on SMD Isaac River Sub-basin Environmental Values and Water Quality Objectives.*	
Copper	1.4 (µg/L)	*For aquatic ecosystem protection, based on SMD Isaac River Sub-basin Environmental Values and Water Quality Objectives.*	
Zinc	8 (µg/L)	*For aquatic ecosystem protection, based on SMD guideline*	
Selenium	5 (µg/L)	*For aquatic ecosystem protection, based on SMD guideline*	
Uranium	0.5 (µg/L)	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Nitrate	400 (mg/L)	*ANZECC stock water drinking guideline*	
Silver	0.05 (µg/L)	*For aquatic ecosystem protection, based on SMD guideline*	
Petroleum hydrocarbons (C6-C9)	20 (µg/L)	*For aquatic ecosystem protection, based on LOR for GCMS*	
Petroleum hydrocarbons (C10-C36)	100 (µg/L)	*For aquatic ecosystem protection, based on LOR for GCMS*	
Sodium	180 (mg/L)	*Australian Human Drinking Water Guidelines. Trigger may require amendment if future advice from Queensland Health becomes available.*	
Barium	2000 µg/L	*Trigger from Australian Human Drinking Water Guidelines*	

NOTE:

1. All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.

*2. The quality characteristics required to be monitored as per **Table C3** can be reviewed once the results of **two (2) years** of monitoring data is available, or if sufficient data is available to adequately demonstrate negligible environmental risk, and it may be determined that a reduced monitoring frequency is appropriate or that certain quality characteristics can be removed from **Table C3** by amendment.*

3. SMD – slightly moderately disturbed level of protection, guideline refers ANZG 2018.

4. LOR – typical reporting for method stated. ICPMS/CV FIMS/GCMS – analytical method required to achieve LOR.

C7	If any of the trigger levels specified in **Table C3 – Release contaminant trigger investigation levels - potential contaminants** are exceeded for any quality characteristic at the release point specified in **Table C1 – Mine affected water release points, sources and receiving waters** during a release event, the environmental authority holder must compare the downstream results in the receiving waters to the trigger values specified in **Table C3 – Release contaminant trigger investigation levels - potential contaminants** and: (a) Where the downstream results do not exceed the trigger values then no action is to be taken; or (b) Where the downstream results exceed the trigger values specified **Table C3 – Release contaminant trigger investigation levels - potential contaminants** for any quality characteristic, compare the results of the downstream site to the data from upstream background monitoring sites (specified in **Table C5 - Receiving waters contaminant trigger levels**); and: (i) where the downstream result is less than the upstream background monitoring site data for the quality characteristic, then no action is to be taken, or (ii) where the downstream result is greater than the upstream background monitoring site data, complete an investigation into the potential for environmental harm and provide a written report to the administering authority within **ninety (90) days** of receiving the result, outlining: (a) details of the investigations carried out; and (b) actions taken to prevent environmental harm. NOTE: *Where an exceedance of a trigger level has occurred and is being investigated, in accordance with* ***Condition C7(b)(ii)*** *of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.*
C8	If an exceedance in accordance with **Condition C7(b)(ii)** is identified, the holder of the environmental authority must notify the administering authority, via WaTERS, within **twenty-four (24) hours** of receiving the result.
C9	**Mine Affected Water Release Events** The holder must ensure a stream flow gauging station/s is installed, operated, and maintained to determine and record stream flows at the locations and flow recording frequency specified in **Table C4 - Mine Affected Water Release During Flow Events**.
C10	The site-specific trigger values identified within **Table C3 - Release contaminant trigger investigation levels - potential contaminants** must be reviewed within **two (2) years** of the commencement of mining activities, or when sufficient monitoring data is available. The *Queensland Water Quality Guidelines* (2009) recommend a minimum of 18 samples collected at each site over at least **12** and preferably **24 months** (in order to capture two complete annual cycles). The administering authority must be notified in writing of the outcome of the review within **fourteen (14) days**.
C11	Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with **Condition C2** of this environmental authority must only take place during periods of natural flow events in accordance with the receiving water flow criteria for discharge specified in **Table C4 - Mine Affected Water Release during Flow Events** for the release point(s) specified in **Table C1 - Mine Affected Water Release Points, Sources and Receiving Waters**.

Table C4 - Mine Affected Water Release during Flow Events

Receiving waters/ stream	Release Point (RP)	Gauging Station (GS)	Gauging Station Easting (GDA20)	Gauging Station Northing (GDA20)	Receiving Water Flow Recording Frequency	Receiving Water Flow Criteria for discharge (m^3/s)[1]	Maximum release rate (m^3/s) (for all combined RP flows)	Electrical Conductivity and (micro-Siemens/cm)[2]
Hat Creek	1	1 Upstream	617623	7587216	Continuous (minimum daily)	Medium Flow 1 >0.5m^3/s	0.05m^3/s	720 µS/cm
						Medium Flow 2 >1.0m^3/s	0.1m^3/s	250 µS/cm
		2 Downstream	620310	7587196		Medium Flow 1 >0.5m^3/s	0.05m^3/s	720 µS/cm
						Medium Flow 2 >1.0m^3/s	0.1m^3/s	250 µS/cm

NOTE:

1 Flow triggers should be compared to natural flow only.
2 Prior to release commencement, an assessment of the water quality of the relevant mine affected water source must be undertaken and the Electrical Conductivity release limit and maximum release rate determined. This determined release limit and maximum release rate applies for the duration of the release

C12	The daily quantity of mine affected water released from each release point must be measured and recorded at the monitoring points in **Table C1 - Mine Affected Water Release Points, Sources and Receiving Waters**.
C13	Releases to waters must be undertaken so as: a) not to cause erosion of the bed and banks of the receiving waters; b) not to cause a material build-up of sediment in such waters; c) not result in any visible discolouration of receiving waters; or d) not result in any slick or other visible or odorous evidence of oil, grease or petrochemicals nor contain visible floating oil, grease, scum, litter or other objectionable matter.
C14	**Notification of Release Event** The environmental authority holder must notify the administering authority, via WaTERS, as soon as practicable and no later than **twenty-four (24) hours** after commencing to release mine affected water to the receiving environment in accordance with **Condition C2**. Notification must include the submission of the following information: a) release commencement date/time; b) details regarding the compliance of the release with the conditions including EC, turbidity, and pH within this environmental authority; c) release location (release point/s); d) release rate; e) release salinity; f) receiving water/s including flow rate when release occurred; g) expected cessation date; and h) expected volume to be discharged.
C15	The administering authority must be notified via WaTERS within **twenty-four (24) hours** after cessation of a release event notified under **Condition C14**. The release cessation notification must include the following information: a) release cessation date/time; b) details of the receiving water; including the natural flow rate; c) volume of water released; d) all in-situ water quality monitoring results; and e) any other matters pertinent to the water release event. NOTE: *Successive or intermittent releases occurring within **twenty-four (24) hours** of the cessation of any individual release can be considered part of a single release event and do not require individual notification for the purpose of compliance with **Conditions C14** and **C15**, provided the relevant details of the release are included within the notification provided in accordance with **Conditions C16, C17** and **C18**.*

C16	Within **twenty-eight (28) days** of the notification under **Condition C14**, the following information must be provided to the administering authority via WaTERS: a) confirmation of: (i) The release commencement date and time; (ii) The release cessation date and time; (iii) Details of the receiving water/s including the natural flow rate; (iv) Volume of water released; b) all in-situ and laboratory water quality monitoring results; c) details assessing compliance of the release with the conditions of **Schedule C – Surface Water** of this environmental authority (i.e. contamination limits, natural flow, discharge volume); d) whether the release resulted in any impacts to the receiving environment; and e) any other matter(s) pertinent to the water release event.
C17	**Notification of Release Event Exceedance** If the release limits defined in **Table C2 - Contaminant Release Limits** are exceeded, the holder of the environmental authority must notify the administering authority, via WaTERS, within **twenty-four (24) hours** of receiving the results.
C18	The environmental authority holder must, within **twenty-eight (28) days** of a release that is not compliant with the conditions of this environmental authority, provide a report to the administering authority, via WaTERS detailing: a) The reason for the release; b) The location of the release; c) The total volume of the release and which (if any) part of this volume was non-compliant; d) The total duration of the release and which (if any) part of this period was non-compliant; e) All water quality monitoring results (including all laboratory analyses); f) Identification of any environmental harm as a result of the non-compliance; g) All calculations; and h) Any other matters pertinent to the water release event.
C19	**Receiving Environment Monitoring and Contaminant Trigger Levels** The quality of the receiving waters must be monitored at the locations specified in **Table C5 - Receiving Water Monitoring Locations** for each quality characteristic and at the monitoring frequency stated in **Table C6 - Receiving Waters Contaminant Trigger Levels**.

C20	**Notification of release event exceedance** If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in **Table C6 - Receiving Waters Contaminant Trigger Levels** during a release event the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and: a) where the downstream result is the same or a lower value than the upstream value for the quality characteristic then no action is to be taken; or b) where the downstream results exceed the upstream results, complete an investigation into the potential for environmental harm and provide a written report to the administering authority via WaTERS by **1 March** each year, outlining: i) details of the investigations carried out; and ii) actions taken to prevent environmental harm. NOTE: *Where an exceedance of a trigger level has occurred and is being investigated, in accordance with* ***Condition C20(b)*** *of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.*
C21	**Monitoring of water storage quality** Water storages specified in **Table C7 – Water Storage Monitoring** must be monitored for: a) the water quality characteristics specified in **Table C2 – Contaminant release limits** and **Table C3 - Release contaminant trigger investigation levels - potential contaminants** at the monitoring locations and frequency specified in **Table C7 – Water Storage Monitoring**; and b) the volume of water held in each of the water storages specified in **Table C7 – Water Storage Monitoring**.

Table C5 - Receiving Water Monitoring Locations

Monitoring points	Receiving Waters Location Description	Easting (GDA20)	Northing (GDA20)
Upstream Background Monitoring Points			
MP3	On-lease, along Hat Creek at the convergence of two watercourse systems from the east	620310	7587196
MP4	Off-lease, along Hat Creek	622473	7586183
Downstream Monitoring Points			
MP1	Off-lease, at the convergence of Hat Creek and a tributary system from the south-east.	617623	7587216
MP2	On-lease, along Hat Creek, near the MAW release point and adjacent to the haul road.	619175	7587536

Table C6 - Receiving Waters Contaminant Trigger Levels

Quality characteristic	Trigger Level	Monitoring Frequency
pH	6.5 – 8.5	Daily during release
Electrical Conductivity (µS/cm)	250 (*NOTE: For protection against toxicity this may need to be reduced in some circumstances e.g. where in close proximity upstream of a drinking water dam or regional waterway.)*	
Total Suspended solids (mg/L)	55	Daily during release
Sulphate (SO_4^{2-}) (mg/L)	25 (*NOTE: Protection of drinking water Environmental Value.)*	
Turbidity (NTU)	50 (*NOTE: Turbidity may be required to assess ecosystems impacts and can provide instantaneous results.)*	

NOTE: *The determination of suitability for release of water should be informed by monitoring undertaken prior to release.*

Table C7 – Water Storage Monitoring

Water Storage Description	Easting(GDA20)	Northing (GDA20)	Monitoring Location	Frequency of Monitoring
Mine Water Dam 1 (MWD1)	619068	7586983	Dam wall	Quarterly
North Pit	619379	7587202	Dam wall	Quarterly

C22	**Receiving Environment Monitoring Program (REMP)** On the commencement of mining activities, the environmental authority holder must implement the Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site. For the purposes of the REMP, the receiving environment is the waters of the Hat Creek and connected or surrounding waterways within 4 km downstream of the mining activity.

C23	The REMP must: a) Assess the condition or state of receiving waters, including upstream conditions, spatially within the REMP area, considering background water quality characteristics based on accurate and reliable monitoring data that takes into consideration temporal variation (e.g., seasonality); and b) Be designed to facilitate assessment against water quality objectives for the relevant environmental values that need to be protected; c) Include monitoring from background reference sites (e.g., upstream or background) and downstream sites from the release (as a minimum, the locations specified in **Table C5 - Receiving Water Monitoring Locations**; d) Specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site specific background reference values in accordance with the *Queensland Water Quality Guideline 2009* or its subsequent revisions. This should include monitoring during periods of natural flow irrespective of mine or other discharges; e) Include monitoring and assessment of dissolved oxygen saturation, temperature and all water quality parameters listed in **Table C2 -Contaminant Release Limits** and **Table C3** -**Release Contaminant Trigger Investigation Levels – Potential Contaminants**; f) Include, where appropriate, monitoring of metals/metalloids in sediments (in accordance with ANZG 2018, *Handbook for Sediment Quality Assessment 2005* and/or the most recent version of AS5667.1 *Guidance on Sampling of Bottom Sediments*); g) Include, where appropriate, monitoring of macroinvertebrates in accordance with the AusRivas methodology, h) Apply procedures and/or guidelines from ANZG 2018 and other relevant guideline documents; i) Describe sampling and analysis methods and quality assurance and control; and j) Incorporate stream flow and hydrological information in the interpretations of water quality and biological data.
C24	A REMP Design Document that addresses each criterion presented in **Conditions C22** and **C23** of this environmental authority must be maintained and submitted to the administering authority on request. Due consideration must be given to any comments made by the administering authority on the REMP Design Document and subsequent implementation of the program.
C25	A report outlining the findings of the REMP, including all monitoring results and interpretations in accordance with **Conditions C22** and **C23** of this environmental authority must be prepared annually. This must include: a) an assessment of background reference water quality; b) the condition of downstream water quality compared against water quality objectives, and c) the suitability of current discharge limits to protect downstream environmental values.
C26	**Water Reuse** Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party (with the written consent of the third party).

C27	**Water general** All determinations of water quality and biological monitoring must be: a) performed by a person or body possessing appropriate experience and qualifications to perform the required measurements; b) made in accordance with methods prescribed in the latest edition of the administering authority's Monitoring and Sampling Manual; c) collected from the monitoring locations identified within this environmental authority, within **ten (10) hours** of each other where possible; d) carried out on representative samples; and e) analysed at a laboratory accredited (e.g., NATA) for the method of analysis being used. NOTE: ***Condition C27*** *requires the Monitoring and Sampling Manual to be followed and where it is not followed because of exceptional circumstances this should be explained and reported with the results.*
C28	**Annual water monitoring reporting** The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority in the specified format by **1 March** each year: a) the date on which the sample was taken; b) the time at which the sample was taken; c) the monitoring point at which the sample was taken; d) the measured or estimated daily quantity of mine affected water released from all release points; e) the release flow rate at the time of sampling for each release point; f) the results of all monitoring and details of any exceedances of the conditions of this environmental authority; and g) water quality monitoring data must be provided to the administering authority via WaTERS.
C29	**Temporary interference with waterways** Temporarily destroying native vegetation, excavating, or placing fill in a watercourse, lake, or spring necessary for and associated with mining operations must be undertaken in accordance with the Department of Regional Development, Manufacturing and Water (DRDMW) *Guideline – Riverine protection permit exemption requirements* (*WSS/2013/726*).
C30	**Water Management Plan** A Water Management Plan must be developed and implemented for the duration of the mining activities authorised under this environmental authority.

C31	The Water Management Plan must: a) Provide for effective management of actual and potential environmental impacts resulting from water management associated with the mining activity carried out under this environmental authority; and b) Be developed in accordance with the administering authority's guideline *Preparation of water management plans for mining activities* (ESR/2016/3111) or its successor and include: i) a contaminant source study; ii) site water balance and model; iii) onsite water quality sampling; iv) a water management system; v) saline drainage prevention and management measures; vi) acid rock drainage prevention and management measures; vii) erosion and sediment control measures; and viii) maintenance of water management and erosion and sediment control infrastructure; onsite sewage management system.
C32	The Water Management Plan required by **Condition C30** must be reviewed each calendar year and a report prepared. The report must: a) Assess the plan against the requirements under **Condition C31;** b) Include recommended actions to ensure actual and potential environmental impacts are effectively managed for the coming year; and c) Identify any amendments made to the Water Management Plan following the review.
C33	**Saline drainage** The holder of this environmental authority must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of saline drainage.
C34	**Acid rock drainage** The holder of this environmental authority must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of acid rock drainage.
C35	**Stormwater and water sediment controls** An Erosion and Sediment Control Plan must be developed and implemented in all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of stormwater.

C36	The Erosion and Sediment Control Plan must: a) demonstrate how erosion and sediment control measures detailed in the plan adequately minimise the release of sediment to receiving waters and must include at least the following: i) an assessment of the size and relevant characteristics of all catchment areas; ii) an assessment of relevant properties of soils and waste materials; iii) identification of receiving waters environmental values, water quality objectives and management intent; iv) specification of minimum design criteria for erosion and sediment control structures to meet the management intent of receiving waters; b) detail the locations and descriptions of all erosion and sediment control measures; and c) provide an audit schedule to ensure erosion and sediment control measures are maintained.
C37	The Erosion and Sediment Control Plan must be reviewed by an appropriately qualified person by **1 March** for each calendar year. The review must be documented and must: a) include a statement that the Erosion and Sediment Control Plan has been reviewed by an appropriately qualified person; b) assess the plan against the requirements of **Condition C36**; c) include recommended actions to ensure actual and potential environmental impacts are effectively managed; d) provide details and timelines of the actions to be taken; and e) identify any amendments made to the Erosion and Sediment Control Plan.
C38	Stormwater, other than mine affected water, is permitted to be released to waters from: a) erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by **Condition C35** of this environmental authority; and b) water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with **Condition C30** for the purpose of ensuring water does not become mine affected water.
C39	Water that has come into contact with uncapped rejects, disposed in accordance with **Condition F16**, is considered mine affected water and must report to the mine affected water storages identified in **Table C7 – Water Storage Monitoring**.
C40	The maintenance and cleaning of any vehicles, plant or equipment must not be carried out in areas from which contaminants can be released into any receiving waters.
C41	Any spillage of wastes, contaminants or other materials must be cleaned up as quickly as practicable to minimise the release of wastes, contaminants or materials to any stormwater drainage system or receiving waters.
C42	**Sewage management** All sewage generated on site must be removed by a licensed contractor at regular intervals. A register must be maintained onsite to keep a track of amount of sewage generated, stored onsite and disposed of via licenced contractor.

Schedule D: Groundwater	
Condition number	**Condition**
D1	**Groundwater** The environmental authority holder must not release contaminants to groundwater.
D2	**Baseline groundwater monitoring program** A baseline groundwater monitoring program must be developed and implemented by an appropriately qualified person(s) (AQP). The baseline groundwater monitoring program must: a) include existing bores as shown in **Table D1 - Groundwater Monitoring Locations and Frequency** and any additional bores deemed necessary by an AQP and the administering authority. b) include at least **eight (8)** sampling events that are no more than **three (3) months** apart over a **twenty-four (24) month** period, to determine background groundwater quality; c) include a conceptual model used to determine the location of groundwater bores and justify; d) identify pre-mining baseline standing water levels and determine groundwater trigger elevations measured in metres above Australian Height Datum (mAHD); e) allow for the identification of natural groundwater level trends and groundwater contaminant limits; f) assess adequacy of monitoring bores network stated in **Table D1 - Groundwater Monitoring Locations and Frequency** to ensure monitoring of impacts within all aquifers present within the mining lease; g) assess adequacy of the monitoring bores depth to ensure predicted drawdown level could can be monitored; h) identify groundwater quality limits and triggers to update **Table D2 - Groundwater quality limits** and submit to the administering authority by **1 April 2024** if required; and i) propose a network of groundwater bores to detect changes, impacts and long-term threats on groundwater aquifers by the south residual void and rehabilitation activities specified in **Appendix 5 (Table G1- Table G1 Post Mine Land Use (PMLU) and Rehabilitation Methods** and **G2 PMLU and rehabilitation success criteria)**.
D3	**Groundwater compliance monitoring** Groundwater quality and levels must be monitored at the locations and frequencies defined in **Table D1 - Groundwater monitoring locations and frequency** and **Figure 3 – Mine affected water release points and monitoring locations** of this authority. NOTE: ***Figure 3 –*** *Mine affected water release points and monitoring locations also shows location of groundwater monitoring bores.*
D4	Groundwater quality monitoring required by **Condition D3**, must be monitored for the parameters outlined in **Table D2 - Groundwater quality limits**. Results and analysis of

	groundwater monitoring must be submitted annually (for period January to December of the previous calendar year) to the administering authority via WaTERS by **1 March** of each calendar year.
D5	For groundwater level monitoring as per **Condition D3**, a groundwater drawdown fluctuation above the magnitude identified in **Table D1 - Groundwater level monitoring locations and frequency** for individual monitoring bores must be notified via WaTERS within fourteen (14) days following completion of monitoring.
D6	Results of monitoring of groundwater quality bores identified in **Table D1 - Groundwater Monitoring Locations and Frequency** must not exceed any of the contaminant limits specified in **Table D2 - Groundwater Quality triggers and limits** for the same monitoring bore on **three (3)** consecutive sampling occasions.
D7	**Exceedance notification** If the contaminant limits specified in **Table D2 - Groundwater Quality limits** are exceeded at the same monitoring bore on **three (3)** consecutive sampling occasions the holder of the environmental authority must notify the administering authority via WaTERS within **twenty-four (24) hours** of receiving the results.
D8	**Exceedance investigation** Within **fourteen (14) days** of notification given under **Conditions D5** and **D7,** an investigation must be completed to determine if the exceedance is a result of: a) mining activities authorised under this environmental authority; or b) seasonal/natural variation; or neighbouring land use resulting in groundwater impacts; or c) any other potential cause not related to the mining activity.
D9	If the investigation under **Condition D8** determines that the exceedance was caused by the mining activities authorised under this environmental authority, then a further investigation must be completed within **twenty-eight (28) days (or a timeframe agreed to with the administering authority)** to determine whether environmental harm has occurred or may occur, and the extent thereof.
D10	If the further investigation undertaken under **Condition D9** determines that environmental harm has occurred, or may occur, the following actions must be completed within **twenty-eight (28) days**: a) implementation of measures as soon as reasonably practicable to reduce environmental harm including potential environmental harm; and b) development of long-term mitigation measures to address any existing groundwater contamination and prevent recurrence of groundwater contamination which is implemented in a reasonable time period; and c) if environmental harm has occurred as a result of groundwater drawdown exceedances, i) determine any actions required to reduce the potential for environmental harm; and ii) determine any mitigation measures required to limit the drawdown in the affected groundwater resource; and d) document the steps taken under **Condition D10 (a), (b),** and **(c),** and provide the documentation to the administering authority within 14 days of implementation.

D11	The following information must be recorded in relation to all groundwater sampling: a) the date on which the sample was taken; b) the time at which the sample was taken; c) the monitoring point at which the sample was taken; and d) the results of all monitoring.
D12	Monitoring and sampling of groundwater must comply with the latest edition of the administering authority's *Monitoring and Sampling Manual*.
D13	**Groundwater Management and Monitoring Program** A Groundwater Management and Monitoring Program must be developed, certified and implemented by an appropriately qualified person for all stages of the mining activities (including construction, mining rehabilitation, and closure) to meet the following requirements: a) identify potential sources of contamination to groundwater aquifers from the authorised mining activity, including the south residual void; identifies all environmental values (including the Hat creek) that must be protected; b) details groundwater levels in all identified aquifers present across and adjacent to the site to confirm existing groundwater flow paths and their interaction with each other and interaction with the Hat Creek, Tivot Brook river system; c) estimates the groundwater inflow to any rehabilitated landforms and surface water ingress to groundwater from flooding events in the form of a groundwater model; d) maps showing the actual water level drawdown contours caused by the take of associated water for each groundwater aquifer details of any review undertaken of the numerical groundwater model and conceptual model; e) an assessment of any differences between the groundwater level impact predicted and actual impacts for corresponding periods in the most current numerical groundwater model; f) ensures all potential adverse groundwater impacts due to mining and rehabilitation activities are identified, monitored and mitigated; g) ensures groundwater monitoring and data analysis is undertaken to: i) detect any impacts to groundwater levels due to mining and rehabilitation activities; ii) detect any impacts to groundwater quality due to mining and rehabilitation activities; iii) determine compliance with **Condition D1**; and iv) determine trends in groundwater quality; h) provides an appropriate quality assurance and quality control program; i) documents groundwater management and monitoring methodologies undertaken for the duration of all mining activities and rehabilitation activities; and j) includes a review process to identify improvements to the program that includes addressing any comments provided by the administering authority.
D14	The Groundwater Management and Monitoring Program required by **Condition D13** must be updated by **30 November 2023** to incorporate data collected from the baseline groundwater monitoring program as detailed in **Condition D2**.
D15	**The Groundwater Management and Monitoring Program Review**

	The Groundwater Management and Monitoring Program required by **Condition D13,** and the data collected must be reviewed at least every **two (2) years** to determine if it continues to meet the requirements stated in **Condition D14**
D16	**The Groundwater Management and Monitoring Program Review Report** A report documenting the outcomes of the review required by **Condition D15** must be provided to the administering authority via WaTERS within **30 business days** from the date of completion of review and must at a minimum: a) show the location of the proposed groundwater bores to detect potential impacts from the mining and rehabilitation activities; b) include the target groundwater aquifer for each of the proposed groundwater bores; c) include the conceptual model used to determine the location of groundwater bores; d) state the methodology used to determine an appropriate number of groundwater bores to be installed; e) a schedule for the construction and commissioning of the groundwater bores; f) how impacts to prescribed environmental matters will be avoided as a result of the disturbance associated with the installation of the proposed bores; and g) standing water level for each of the groundwater bores.
D17	**Bore construction and maintenance and decommissioning** The construction, maintenance, and management of groundwater bores (including groundwater monitoring bores) must be undertaken in a manner that prevents or minimises impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring.
D18	Any groundwater monitoring bores that are mined through during operations must be replaced with bores in the equivalent Screen Stratigraphy, and updated details provided in **Table D1 - Groundwater monitoring locations and frequency**.

Table D1- Groundwater monitoring locations and frequencies

Location Description	Monitoring Point	Environmental Value Monitoring	Easting (GDA20)	Northing (GDA20)	Pre-mining baseline standing water levels (mbTOC)[6]	Drawdown Trigger Levels (m)	Groundwater trigger elevation (mAHD)[4]	Monitoring Frequency
Monitoring Bores								
Rangal Coal Measure	MBBE0008	Groundwater	620294	7585092	19.59	5	282.62	Quarterly measurements of SWL[5] Quarterly EC and pH Six monthly for remaining analytes
Rangal Coal Measure	BDW172 (54) [1]	Groundwater	619376	7586650	19.83	35	234.52	
Rangal Coal Measure	BDW8C [1]	Groundwater	619782	7585651	21.54	63	217.61	
Rangal Coal Measure	BDW5C [1]	Groundwater	619687	7586758	15.74	5	271.40	
Rewan Group	BDW172 (32) [1]	Groundwater	619376	7586650	13.32	7	269.03	
Tertiary Sediments	MBBE0002b [2]	Terrestrial GDE within the riparian corridor near Hat and Spade creek	618436	7585329	12.57	2	331.86	
Basalt	MBBE0003 [2]	Groundwater	618431	7584664	N.A	5	N.A	
Alluvium	MBBE0004 [2]	Terrestrial GDE within the riparian corridor near Hat and Spade creek	620205	7586976	N.A	2	N.A	

Alluvium	MBBE0006 [1,2]	Terrestrial GDE within the riparian corridor near Hat and Spade creek	619173	7587205	N.A	2	N.A	
Compliance Bores								
Rangal Coal Measures	MBBE0001 [1,3]	Groundwater	619884	7585428	42.20	57	206.01	Quarterly measurements of SWL[1] Quarterly EC and pH Six monthly for remaining analytes[2]
Rewan Group	MBBE0007	Groundwater	620615	7586415	24.90	23	249.92	

NOTE:
1. *To be monitored until mined out.*
2. *Some bores are often dry and unavailable for water levels.*
3. *MBBE0001 to be replaced in Year 3 by another bore*
4. *Groundwater trigger elevations are conversion of drawdown trigger levels(m) to mAHD – metres above Australian height Datum*
5. *Quarterly or more frequently following granting of this Environmental Authority*
6. *mbTOC – metres below top of casing*

Table D2 – Groundwater quality limits

Monitoring point	Parameter	pH	EC	Sulfate (SO_4)	Arsenic	Aluminium	Molybdenum	Selenium	Major ions
	Sample	Range	Max	Max	Max	Max	Max	Max	Interpretation Only
	Unit	pH units	(µS/cm)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
MBBE0001		6.5 – 8.5	888.3	0.5	0.002	0.08	0.001	0.005	
MBBE0007			48,540	937.6	0.005	0.37	0.025	0.046	

NOTE:

All metals must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal apply if dissolved results exceed trigger.

Triggers are based on 95th percentile results from all groundwater quality analyses from each monitoring bore.

Schedule E: Noise and Vibration	
Condition number	**Condition**
E1	**Noise nuisance** Noise, vibration and air blast overpressure resulting from the authorised mining activities must not cause a nuisance at any sensitive receptor.
E2	A **Noise and Vibration Management Plan** must be implemented at the site and include the following as a minimum: a) be developed by an appropriately qualified person; b) identification of all potential sensitive receptors which may be affected by noise and vibration impacts from the mining activities; c) identification of all major sources of noise and vibration emissions that may occur as a result of the operation of the project; d) description of the procedures to manage the noise and vibration emissions from the sources identified; e) collection of noise and vibration data as per **Condition E3**; f) identifying adverse meteorological conditions likely to produce elevated levels of noise and vibration at a sensitive or commercial place due to mining activities; g) integration of noise and vibration control strategies; h) protocols for regular maintenance of plant and equipment, to minimise the potential for noise and vibration emissions; and i) description of procedures to be undertaken if any exceedance is detected.
E3	**Noise monitoring** Noise from the authorised mining activities must not exceed the limits specified in **Table E1 - Noise limits** and **Table E2 - Blasting Noise Limits** at any sensitive receptor. If the environmental authority holder can provide monitoring evidence at the time of the alleged exceedance that the limits defined in **Table E1 - Noise Limits** and **Table E2 - Blasting Noise Limits** , are not being exceeded then the holder is not in breach of **Condition E1** of this environmental authority.
E4	Monitoring required by **Condition E3** must be conducted in accordance with the administering authority's *Noise Measurement Manual* (ESR/2016/2195) and all recordings must include the following descriptor characteristics and matters: a) LAN,T (where N equals the statistical levels of 1, 10 and 90 and T = 1 hour) b) background noise LA90 c) the level and frequency of occurrence of impulsive or tonal noise and any adjustment and penalties to statistical levels d) atmospheric conditions including temperature, relative humidity and wind speed and directions e) effects due to any extraneous factors such as traffic noise f) location, date and time of monitoring g) if the complaint concerns low frequency noise, Max LpLIN,T and one third octave band measurements in dB(LIN) for centre frequencies in the 10 – 200 Hz range.

E5	If monitoring indicates exceedance of the limits in **Table E1 - Noise Limits** and **Table E2 - Blasting Noise Limits**, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement noise abatement measures so that emissions of noise from the activity do not result in further environmental nuisance.
E6	If during monitoring as required by **Condition E3**, there is an exceedance of the relevant limits listed in **Table E1 - Noise limits** and **Table E2 - Blasting Noise Limits**, the administering authority must be notified of the exceedance occurring within **twenty-four (24) hours** as per **Condition A15**. The notification must also detail the actions taken in accordance with **Condition E5**.
E7	**Vibration nuisance** Subject to **Conditions A13** and **E8** of this environmental authority vibration from the mining activity must not cause an environmental nuisance, at any sensitive receptor.
E8	If the environmental authority holder can provide monitoring evidence that the limits defined in **Table E2 – Blasting Noise Limits**, are not being exceeded then the holder is not in breach of **Condition A13** of this environmental authority. Monitoring must include: a) peak particle velocity (mm/s); b) air blast overpressure level (dB linear peak); c) location of the blast/s within the mining area (including which bench level); d) atmospheric conditions including temperature, relative humidity and wind speed and direction; and e) location, date, and time of recording.
E9	Blast monitoring must be conducted in accordance with the most recent edition of the administering authority's guideline *Noise and vibration from blasting* (ESR/2016/2169) or relevant Australian Standards.
E10	For the purposes of **Condition E7** of this environmental authority, the mining activities will not cause environmental nuisance where noise from the mining activities does not exceed the criteria specified in **Table E2 – Blasting Noise Limits**.
E11	If monitoring indicates exceedance of the limits in **Table E2 – Blasting Noise Limits**, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement noise abatement measures so that emissions of noise from the activity do not result in further environmental nuisance.
E12	Every explosive blast for the mining activity shall be designed by a competent person to achieve the criteria specified in **Table E2 – Blasting Noise Limits**.
E13	All relevant information pertaining to the design of every explosive blast for the mining activity in relation to the criteria specified in **Table E2 - Blasting Noise Limits** shall be kept in written and diagrammatic form.

Table E1 - Noise limits

Noise level dB(A)	Monday to Sunday (including public holidays)		
	7am - 6pm	6pm - 10pm	10pm - 7am
	Noise measured at a 'Sensitive receptor'		
$L_{Aeq, Adj, 1hr}$	40	40	35
$L_{A1, adj, 1hr}$	50	50	45

NOTE: *Table E1 does not purport to set operating hours for the mining activities.*

Table E2 - Blasting Noise Limits

Noise Level dB(A)	Sensitive or commercial place	
	7am – 6pm	6pm – 7am
Airblast overpressure	115 dB (Linear) Peak for 4 out of 5 consecutive blasts initiated and not greater than 120 dB (Linear) Peak at any time.	No blasting to occur
Ground vibration peak particle velocity	5mm/second peak particle velocity for 4 out of 5 consecutive blasts and not greater than 10 mm/second peak particle velocity at any time	No blasting to occur

NOTE: *Table E2 does not purport to set limits applicable to any particular explosive blast, rather sets design criteria for every explosive blast.*

Schedule F: Waste	
Condition number	**Condition**
F1	**Waste Management Plan** A Waste Management Plan must be developed and implemented for all stages of mining activities. The Waste Management Plan must at a minimum include the following: a) types and amounts of regulated waste generated, including rejects; b) description of how the types of regulated waste are generated and will be dealt with under the waste and resource management hierarchy; c) procedures for identifying and implementing opportunities to minimise the amount of regulated waste generated and improve practices employed; d) procedures for dealing with accidents, spills and incidents that may impact on waste management; e) staff training on matters relevant to regulated waste management; and f) mechanisms and dates for review of the waste management plan.
F2	Waste must not be burnt or allowed to burn on the site unless permitted by the administering authority.
F3	A designated area must be set aside for the segregation of economically viable recycling solid or liquid waste.
F4	Site contamination will be assessed at relinquishment of the mining tenure according to the *Environmental Protection Act 1994*, with results and any required remediation actions detailed in the Final Rehabilitation Report.
F5	Records of trade waste or material leaving the Mining Lease for recycling or disposal, including the final destination and method of treatment, in accordance with the *Environmental Protection Act 1994*, will be maintained and be made available for inspection by an authorised person or the administering authority.
F6	**Inert demolition and construction waste disposal** Inert demolition and construction waste must only be disposed of into the spoil emplacements disposal area consistent with the site Waste Management Plan.
F7	Deposited waste must be covered as soon as practicable to limit stormwater infiltration, prevent exposure of waste, and prevent issues arising from vectors and pest species.
F8	All reasonable and practicable measures must be taken to contain litter within the waste operations area, and retrieve litter released.
F9	The only types of regulated waste authorised to be disposed are scrap tyres and rejects.
F10	A register recording all volumes and locations of regulated waste disposed must be established and maintained to ensure that the information contained in the register is current and complete on any given day.

F11	**Storage of tyres** Scrap tyres stored awaiting disposal or transport for take-back and recycling, or waste-to-energy options must be stored in stable stacks and at least **ten (10) meters** from any other scrap tyre storage area, or combustible or flammable material, including vegetation.
F12	All reasonable and practicable fire prevention measures must be implemented, including removal of grass and other materials within a **ten (10) meter** radius of the scrap tyre storage area.
F13	Where no feasible recycling or waste to energy options are available, disposing of scrap tyres resulting from the mining activities in spoil emplacements is acceptable, provided tyres are placed as deep in the spoil as reasonably practicable.
F14	Scrap tyre waste disposal areas on the mining lease will be capped with two meters of inert material and revegetated in accordance with available and recognised best practice following the cessation of their use as disposal areas in a manner that will encourage run-off.
F15	Scrap tyres resulting from the mining activities disposed within the operational land must not impede saturated aquifers or compromise the stability of the consolidated landform.
F16	**Rejects disposal** The only regulated waste authorised to be disposed of under environmentally relevant activity 60(1) is rejects and it must be disposed in accordance with **Conditions F17** and **F18**.
F17	Rejects are authorised to be disposed of within spoil emplacements in the following disturbance areas: a) out of pit overburden dumps; and b) central pit.
F18	Rejects must be disposed of according to, at a minimum, the following emplacement design criteria: a) each emplacement is not more than **50 metres** in width and **100 metres** in length; b) there is not less than **ten (10) metres** in between rejects emplacements; and c) each emplacement is not less than **ten (10) metres** from a spoil dump boundary.

Schedule G: Land and Biodiversity	
Condition number	**Condition**
G1	**Preventing contaminant release to land** Contaminants must not be released to land unless otherwise authorised by a condition of this environmental authority.
G2	**Topsoil** Topsoil resources that are suitable for use in rehabilitation must be salvaged ahead of mining disturbance for strategic use in rehabilitation of the mine area.
G3	A **Topsoil Management Plan** must be developed, implemented, and made available to the administering authority upon request. The Topsoil Management Plan must contain topsoil management strategies including but not limited to: a) Topsoil stripped and stockpiled in advance of mining activities; b) Measures to ensure that the mixing and erosion of topsoil and overburden stockpiles is prevented; and c) A topsoil inventory which identifies the topsoil requirements and availability of suitable topsoil on site for the mining activity must be maintained and made available on request by the administering authority.
G4	**Mineral Waste** A **Mineral Waste Management Plan** must be developed and implemented for the duration of the mining activities. The plan must include at a minimum: a) a program of progressive sampling and characterisation to identify the physical properties of mineral waste, the dispersive and non-dispersive material, salinity, acid and alkali producing potential, and metal concentrations; b) the availability or leachability of metals from mineral waste; c) a materials balance and disposal plan demonstrating how potentially acid forming, acid forming and sodic mineral waste will be selectively placed and/or encapsulated; d) where relevant, a sampling program to verify encapsulation and/or placement of potentially acid forming, acid-forming and sodic mineral waste; e) details as to how seepage and leachability from mineral waste will be managed both during operation and the foreseeable future; and f) mechanisms for review of the Mineral Waste Management Plan.
G5	**Rehabilitation and final landform design** All areas significantly disturbed by mining activities must be rehabilitated to a safe, stable, non-polluting landform with a self-sustaining vegetation cover in accordance with the following**:** a) **Appendix 5, Table G1 - Post Ming Land Use (PMLU) and Rehabilitation Methods**; b) **Appendix 5, Table G2 - PMLU Rehabilitation Success Criteria;** c) The Rehabilitation Management Plan required by **Condition G10**; and d) A Residual Void Design and Closure Plan required by **Condition G7.**

G6	**Residual Void Outcome** Only the residual void detailed in **Appendix 5**, **Table G1 - Post Mine Land Use (PMLU) and Rehabilitation Methods**, is permitted at the approved place located as per **Figure 4 - Final Landform.** The residual void must comply with its design requirements specified in **Appendix 5**, **Table G2 - PMLU Rehabilitation Success Criteria**
G7	The south residual void as detailed in **Appendix 5**, **Table G1 - Post Mine Land Use (PMLU) and Rehabilitation Methods** must act as groundwater sink to the receiving groundwater environment.
G8	A Residual Void Design and Closure Plan must be developed and submitted for a review to the administering authority by **29 September 2023**.
G9	Within **twenty (20) business days** of receiving comments from the administering authority as per **Condition G8**, a Residual Void Design and Closure plan must be updated by the AQP to address any comments suggested by the administering authority.
G10	A Residual Void (Southern void) Design and Closure Plan required by **Condition G8** must include, but is not limited to, the following details: a) a study of options available for minimising residual void area and volume; b) detailed design criteria and rehabilitation methodology of residual voids in accordance with **Appendix 5**, **Table G1 - Post Mine Land Use (PMLU) and Rehabilitation Methods** and **Table G2 - PMLU Rehabilitation Success Criteria**; c) a void hydrology study, addressing the long-term water balance in the void, connections to groundwater resources and water quality parameters in the long-term; d) a pit wall stability study, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events; e) a study of void capability to support a PMLU of stock watering as per the relevant Water Quality Objectives; f) a proposal/s for end of mine void rehabilitation success criteria and residual void areas and volumes; and g) post closure monitoring and management requirements. NOTE*: At the completion of decommissioning and rehabilitation, the residual void must be protected from Probable Maximum Floods (PMFs) from nearby watercourses such that the protection is sustainable for the foreseeable future.*

G11	**Rehabilitation Management Plan** A Rehabilitation Management Plan for all areas disturbed by the authorised mining activities must be developed and implemented by an appropriately qualified person that includes, at a minimum, the following: a) a map of proposed areas of rehabilitation including classification and status of rehabilitation; b) a strategy and schedule for the progressive rehabilitation of all disturbance during the life of mine; c) a strategy for weed and pest management which includes disturbed and rehabilitated areas; d) a strategy for successfully achieving rehabilitation requirements of this environmental authority; e) details of the grazing trials; f) details of landform design to achieve rehabilitation outcomes listed in **Appendix 5**, **Table G1 - Post Mine Land Use (PMLU) and Rehabilitation Methods** including end of mine design and schematic representation of final landform inclusive of: i. drainage design and features; ii. slope designs; iii. cover design; iv. erosion controls proposed on reformed land; g) details of how landform design will be consistent with surrounding topography; h) details of how the final land uses will align with local planning scheme requirements; i) specify the spoil characteristics, soil analysis and soil separation for use on rehabilitation; j) specify the topsoil requirements for the site and how topsoil will be managed for use in rehabilitation; k) details of any topsoil deficit and how any deficit will be managed for successful rehabilitation; l) details of rehabilitation methods to be applied to each domain as per **Appendix 5**, **Table G1 Post Mine Land Use (PMLU) and Rehabilitation Methods,** including defined water quality parameters for water structures to be retained onsite post mine; m) describe the monitoring of reference sites; n) description of rehabilitation indicators and how these will be monitored; o) description of management actions to address unsuccessful rehabilitation or redesign; p) description of wastewater collection and reticulation and treatment systems; q) description of any risks to groundwater and how these will be managed; and r) description of seepage and leachate management considerations.
G12	The Rehabilitation Management Plan required by **Condition G11** must be submitted to the administering authority for review and comment before **29 September 2023**.
G13	Within **twenty (20) business days** of receiving comments from the administering authority as per **Condition G12**, the Rehabilitation Management Plan must be updated by the appropriately qualified person to address any comments suggested by the administering authority.
G14	Rehabilitation must commence and be undertaken progressively in accordance with the Rehabilitation Management Plan required by **Condition G11.**
G15	**Rehabilitation Monitoring Program** A Rehabilitation Monitoring Program must be developed and implemented by an appropriately qualified person for the life of this environmental authority.

G16	A review of the Rehabilitation Monitoring Program required by **Condition G15** must occur at intervals no greater than **thirty-six (36) months** from the commencement of the mining activities.
G17	A report of the findings of the rehabilitation monitoring program review required by **Condition G16**. The report must contain the following: a) how the rehabilitation objectives in the Rehabilitation Management Plan required by **Condition G4** are being met; b) if the rehabilitation objectives are not being met, the corrective actions to be taken; c) a statistical analysis of how areas of rehabilitation compare to reference sites; d) a statistical analysis of how areas of rehabilitation are meeting the requirements of **Condition G11**; e) the sampling and monitoring intensity used in the Rehabilitation Monitoring Program required by **Condition G15**; and f) justification of the sampling and monitoring intensity used in the Rehabilitation Monitoring Program required by **Condition G15**.
G18	**Infrastructure** All infrastructure, constructed by or for the environmental authority holder during the mining activities including water storage structures, must be removed from the site prior to mining lease surrender, except where agreed in writing by the post mining landowner / holder. NOTE: *This is not applicable where the landowner/holder is also the environmental authority holder.*
G19	The characteristics of overburden must be determined prior to disturbance by mining to a standard sufficient to enable selective handling of materials required.
G20	Cleared vegetation from the site must be managed in accordance with the following hierarchy: a) reuse, e.g., use of logs and tree stumps as shelter for fauna in rehabilitated areas; b) recycle, e.g., mulching of vegetation and use in rehabilitation on the site; and c) other alternative management options implemented in a way that causes the least amount of environmental harm.
G21	**Chemical Storage** Chemicals and fuels stored, must be effectively contained and where relevant, meet Australian Standards, where such a standard is applicable. Where no standard exists, storage of such materials must be within an effective on-site containment system.

Schedule H: Regulated Structures	
Condition number	**Condition**
H1	**Assessment of consequence category** The consequence category of any structure must be assessed by a suitably qualified and experienced person in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (ESR/2016/1933) at the following times: a) prior to the design and construction of the structure, if it is not an existing structure; or b) prior to any change in its purpose or the nature of its stored contents.
H2	A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.
H3	Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (ESR/2016/1933).
H4	**Design and construction[1] of a regulated structure** **Conditions H5** to **H9** inclusive do not apply to existing structures.
H5	All regulated structures must be designed by, and constructed[2] under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (ESR/2016/1933).
H6	Construction of a regulated structure is prohibited unless the holder has submitted a consequence category assessment report and certification to the administering authority has been certified by a suitably qualified and experienced person for the design and design plan and the associated operating procedures in compliance with the relevant condition of this authority.
H7	Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (ESR/2016/1933) and must be recorded in the Register of Regulated Structures.

[1] Construction of a dam includes modification of an existing dam — refer to the definitions.
[2] Certification of design and construction may be undertaken by different persons.

H8	Regulated structures must: a) be designed and constructed in accordance with and conform to the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (ESR/2016/1933); b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of: i) floodwaters from entering a regulated dam from any watercourse or drainage line; and ii) wall failure due to erosion by floodwaters arising from any watercourse or drainage line. c) for regulated dams that are dams associated with a failure to contain – seepage: have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.
H9	Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that: a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure; b) construction of the regulated structure is in accordance with the design plan.
H10	**Operation of a regulated structure** Operation of a regulated structure, except for an existing structure, is prohibited unless the holder has submitted to the administering authority: a) one electronic copy of the design plan and certification of the ‘design plan’ in accordance with **Condition H6**, and b) a set of ‘as constructed’ drawings and specifications, and c) certification of those ‘as constructed drawings and specifications’ in accordance with **Condition H9**, and d) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan. e) the requirements of this authority relating to the construction of the regulated structure have been met; f) The holder has entered the details required under this authority, into a Register of Regulated Dams; and g) There is a current operational plan for the regulated structures.
H11	Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in a manner that is consistent with the current operational plan and, if applicable, the current design plan and associated certified ‘as constructed’ drawings.
H12	**Mandatory reporting level** **Conditions H14 to H17** inclusive only apply to regulated dams which have not been certified as low consequence category for ‘failure to contain – overtopping’.

H13	The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.
H14	The holder must, as soon as practical and within **forty-eight (48) hours** of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.
H15	The holder must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.
H16	The holder must record any changes to the MRL in the Register of Regulated Structures.
H17	**Design Storage Allowance** The holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken **prior to 1 July** of each year.
H18	By **1 November** of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).
H19	The holder must, as soon as possible and **within forty-eight (48) hours** of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on **1 November** of any year, notify the administering authority.
H20	The holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on **1 November** of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.
H21	**Annual Inspection report** Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.
H22	At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include recommended actions to ensure the integrity of the regulated structure.
H23	The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (ESR/2016/1933).

H24	The holder must: a) Within **twenty (20) business days** of receipt of the annual inspection report, provide to the administering authority: i) The recommendations section of the annual inspection report; and ii) If applicable, any actions being taken in response to those recommendations; and b) If, following receipt of the recommendations and (if applicable) actions, the administering authority requests a full copy of the annual inspection report from the holder, provide this to the administering authority within **ten (10) business days** of receipt of the request.
H25	**Transfer arrangements** The holder must provide a copy of any reports, documentation and certifications prepared under this authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.
H26	**Decommissioning and rehabilitation** Dams must not be abandoned but be either: a) decommissioned and rehabilitated to achieve compliance with **Condition H28**; or b) be left in-situ for a beneficial use(s) provided that: i) it no longer contains contaminants that will migrate into the environment; ii) it contains water of a quality that is demonstrated to be suitable for its intended beneficial use(s); and iii) the administering authority, the holder of the environmental authority and the landholder agree in writing that the dam will be used by the landholder following the cessation of the environmentally relevant activity(ies).
H27	After decommissioning, all significantly disturbed land caused by the carrying out of the environmentally relevant activity(ies) must be rehabilitated to meet the following final acceptance criteria: a) the landform is safe for humans and fauna; b) the landform is stable with no subsidence or erosion gullies for at least **three (3) years**; c) any contaminated land (e.g. contaminated soils) is remediated and rehabilitated; d) not allowing for acid mine drainage; e) there is no ongoing contamination to waters (including groundwater); f) rehabilitation is undertaken in a manner such that any actual or potential acid sulfate soils on the area of significant disturbance are treated to prevent or minimise environmental harm in accordance with the *Instructions for the treatment and management of acid sulfate soils* (2001); g) all significantly disturbed land is reinstated to the pre-disturbed land suitability class; and h) for land that is not being cultivated by the landholder: i) groundcover, that is not a declared pest species is established and self-sustaining; ii) vegetation of similar species richness and species diversity to pre-selected analogue sites is established and self-sustaining; iii) the maintenance requirements for rehabilitated land is no greater than that required for the land prior to its disturbance caused by carrying out the resource activities;

	iv) for land that is to be cultivated by the landholder, cover crop is revegetated, unless the landholder will be preparing the site for cropping within **three (3) months** of the resource activities being completed.
H28	**Register of Regulated Structure** A Register of Regulated Structures must be established and maintained by the holder for each regulated dam.
H29	The holder must provisionally enter the required information in the Register of Regulated Structures when a design plan for a regulated structure is submitted to the administering authority.
H30	The holder must make a final entry of the required information in the Register of Regulated Structures once compliance with **Condition H10** to **H11** has been achieved.
H31	The holder must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day.
H32	All entries in the Register of Regulated Structures must be approved by the chief executive officer for the holder of this authority, or their delegate, as being accurate and correct.

Definitions

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

"accepted engineering standards" in relation to dams, means those standards of design, construction, operation and maintenance that are broadly accepted within the profession of engineering as being good practice for the purpose and application being considered. In the case of dams, the most relevant documents would be publications of the Australian National Committee on Large Dams (ANCOLD), guidelines published by Queensland government departments, and relevant Australian and New Zealand Standards.

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

a) vegetation establishment, survival and succession;

b) vegetation productivity, sustained growth and structure development;

c) fauna colonisation and habitat development;

d) ecosystem processes such as soil development and nutrient cycling, and the recolonisation of specific fauna groups such as collembola, mites and termites which are involved in these processes;

e) microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration;

f) effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development;

g) resilience of vegetation to disease, insect attack, drought and fire; and

h) vegetation water use and effects on ground water levels and catchment yields.

"acid sulfate soil(s)" means a soil or soil horizon which contains sulfides or an acid soil horizon affected by oxidation of sulfides.

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

"administering authority" means the Department of Environment and Science or its successor.

"AEP" means the Annual Exceedance Probability, which is the probability that at least one event in excess of a particular magnitude will occur in any given year.

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

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

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

a) against recommendations contained in previous annual inspections reports;

b) against recognised dam safety deficiency indicators;

c) for changes in circumstances potentially leading to a change in consequence category;

d) for conformance with the conditions of this authority;

e) for conformance with the ‘as constructed’ drawings;

f) for the adequacy of the available storage in each regulated dam, based on an actual observation or observations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the **dam** (or network of linked containment systems);

g) for evidence of conformance with the current operational plan.

“APPEA Code” means the current APPEA, Code of Environmental Practice.

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

“areas of pre-existing disturbance” means areas where environmental values have been negatively impacted as a result of anthropogenic activity and these impacts are still evident. Areas of pre-disturbance may include areas where legal clearing, logging, timber harvesting, or grazing activities have previously occurred, where high densities of weed or pest species are present which have inhibited re-colonisation of native regrowth, or where there is existing infrastructure (regardless of whether the infrastructure is associated with the authorised petroleum activities). The term ‘areas of pre-disturbance’ does not include areas that have been impacted by wildfire/s, controlled burning, flood or natural vegetation die-back.

“authority” means environmental authority (mining activities) under the *Environmental protection Act 1994*.

“AS2885” means the *Australian Standard Pipelines – Gas and Liquid Petroleum.*

“assessed” or **“assess”** by a suitably qualified and experienced person in relation to a hazard assessment of a structure, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit at any time:

a) exactly what has been assessed and the precise nature of that assessment;

b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;

c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and

d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

“associated water” is defined in section 185 of the *Petroleum and Gas (Production and Safety) Act 2004* and means underground water taken or interfered with, if the taking or interference happens during the course of, or results from, the carrying out of another authorised activity under a petroleum authority, such as a petroleum well, and includes waters also known as produced formation water. The term includes all contaminants suspended or dissolved within the water.

“associated works” in relation to a dam, means:

a) operations of any kind and all things constructed, erected or installed for that dam; and

b) any land used for those operations.

“background noise level” means the sound pressure level, measured in the absence of the noise under investigation, as the LA90, T being the A-weighted sound pressure level exceeded for 90% of the measurement time period T of not less than 15 minutes, using Fast response.

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

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

a) of benefit to that owner in that it adds real value to their business or to the general community,

b) in accordance with relevant provisions of the *Environmental Protection Act 1994*,

c) sustainable by virtue of written undertakings given by that owner to maintain that dam, and

d) the transfer and use have been approved or authorised under any relevant legislation.

“blasting” means the use of explosive materials to fracture-

a) rock, coal and other minerals for later recovery; or

b) structural components or other items to facilitate removal from a site or for reuse.

“bunded” means within bunding consistent with Australian Standard 1940.

“certification”, “certifying” or **“certified”** by an appropriately qualified and experienced person in relation to a design plan or an annual report regarding dams/structures, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit at any time:

a) exactly what is being certified and the precise nature of that certification;

b) the relevant legislative, regulatory and technical criteria on which the certification has been based;

c) the relevant data and facts on which the certification has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and

d) the reasoning on which the certification has been based using the relevant data and facts, and the relevant criteria.

“chemical” means:

a) an agricultural chemical product or veterinary chemical product within the meaning of the *Agricultural and Veterinary Chemicals Code Act 1994* (Commonwealth); or

b) a dangerous good under the Australian Code for the Transport of Dangerous Goods by Road and Rail approved by the Australian Transport Council; or

c) a lead hazardous substance within the meaning of the *Workplace Health and Safety Regulation 1997*;

d) a drug or poison in the Standard for the Uniform Scheduling of Drugs and Poisons prepared by the Australian Health Ministers’ Advisory Council and published by the Commonwealth; or

e) any substance used as, or intended for use as:

   i) a pesticide, insecticide, fungicide, herbicide, rodenticide, nematicide, miticide, fumigant or related product; or

   ii) a surface active agent, including, for example, soap or related detergent; or

   iii) a paint solvent, pigment, dye, printing ink, industrial polish, adhesive, sealant, food additive, bleach, sanitiser, disinfectant, or biocide; or

   iv) a fertiliser for agricultural, horticultural or garden use; or

   v) a substance used for, or intended for use for mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater; or

   vi) manufacture of plastic or synthetic rubber.

“clearing” means:

a) in relation to grass, scrub or bush – the removal of vegetation by disturbing root systems and exposing underlying soil (including burning), but does not include –

   i) the flattening or compaction of vegetation by vehicles if the vegetation remains living; or

   ii) the slashing or mowing of vegetation to facilitate access tracks; or

   iii) the clearing of noxious or introduced plant species; and

b) in relation to trees – cutting down, ringbarking, pushing over, poisoning or destroying in any way.

“commercial place” means a workplace used as an office or for business or commercial purposes, which is not part of the mining activity and does not include employees accommodation or public roads.

“competent person” means a person with the demonstrated skill and knowledge required to carry out the task to a standard necessary for the reliance upon collected data or protection of the environment.

“completion criteria” these are the standards that are to be met by successful rehabilitation. They will generally be in the form of numerical values that can be verified by measurement of the indicators selected for the rehabilitation objectives. They may include an element based on time, e.g. the criterion has been achieved for 7 consecutive years for 95 percent of the area.

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

“consequence category” means a category, either low, significant or high, into which a structure is assessed as a result of the application of tables and other criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)*.

“construction” includes building a new regulated structure and modifying or lifting an existing regulated structure.

“contaminate” means to render impure by contact or mixture.

“contaminated” means the substance has come into contact with a contaminant.

“contaminant” – a contaminant can be:

a) a gas, liquid or solid; or

b) an odour; or

c) an organism (whether alive or dead), including a virus; or

d) energy, including noise, heat, radioactivity and electromagnetic radiation; or

e) a combination of contaminants.

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

“dam” means a land-based structure or a void that is designed to contain, divert or control flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works. However; a dam does *not* mean a fabricated or manufactured tank or container designed to a recognised standard, *nor* does a dam mean a land-based structure where that structure is designed to an Australian Standard. In case there is any doubt, a levee (dyke or bund) is a dam, but (for example) a bund designed for spill containment to AS1940 is *not* a dam.

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

“declared pest plants” are listed in Schedule 2 of the Land *Protection (Pest and Stock Route Management) Regulation 2003*.

“design plan” is the documentation required to describe the physical dimensions of the dam, the materials and standards to be used for construction of the dam, and the criteria to be used for operating the dam. The documents must include design and investigation reports, specifications and certifications, together with the planned decommissioning and rehabilitation works and outcomes. A design plan may include ‘as constructed’ drawings.

“design storage allowance” or **“DSA”** means the minimum storage required in a dam at the first of November each year in order to meet the hydraulic performance requirements.

“development approval” means a development approval under the *Integrated Planning Act 1997* or the *Sustainable Planning Act 2009* in relation to a matter that involves an environmentally relevant activity under the *Environmental Protection Act 1994*.

“disturbance” of land includes:

a) compacting, removing, covering, exposing or stockpiling of earth;

b) removal or destruction of vegetation or topsoil or both to an extent where the land has been made susceptible to erosion;

c) carrying out mining within a watercourse, waterway, wetland or lake;

d) the submersion of areas by tailings or hazardous contaminant storage and dam/structure walls;

e) temporary infrastructure, including any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be removed after the mining activity has ceased; or

f) releasing of contaminants into the soil, or underlying geological strata.

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

g) areas off lease (e.g. roads or tracks which provide access to the mining lease);

h) areas previously disturbed which have achieved the rehabilitation outcomes;

i) by agreement with the administering authority, areas previously disturbed which have not achieved the rehabilitation objective(s) due to circumstances beyond the control of the mine operator (such as climatic conditions);

j) areas under permanent infrastructure. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be left by agreement with the landowner.

k) disturbance that pre-existed the grant of the tenure.

"dwelling" means any of the following structures or vehicles that is principally used as a residence –

a) a house, unit, motel, nursing home or other building or part of a building; or

b) a caravan, mobile home or other vehicle or structure on land; or

c) a watercraft in a marina.

"EC" means electrical conductivity

"effluent" treated wastewater discharged from sewage treatment plants.

"end" means the stopping of the particular activity that has caused a significant disturbance in a particular area. It refers to, among other things, the end of a seismic survey or the end of a drilling operation. It does not refer to the end of all related activities such as rehabilitation. In other words, it does not refer to the 'completion' of the particular activity, the time at which the petroleum authority ends or the time that the land in question ceases to be part of the authority. Under the APPEA Code 'completion' refers to the point at which the particular survey, program or operation has been rehabilitated and abandoned.

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

"environmental authority" means an environmental authority under Chapter 5 of the *Environmental Protection Act 1994.*

"environmental authority holder" means the holder of this environmental authority.

"environmental nuisance" is defined in section 15 of the *Environmental Protection Act* 1994 and is unreasonable interference or likely interference with an environmental value caused by:

a) aerosols, fumes, light, noise, odour, particles or smoke; or

b) an unhealthy, offensive or unsightly condition because of contamination; or

c) another way prescribed by regulation**.**

"environmentally relevant activity" means an environmentally relevant activity as defined under Section 18 of the *Environmental Protection Act 1994* and listed in the *Environmental Protection Regulation 1998.*

"equivalent person" means an equivalent person as defined in Item 63 of Schedule 2 in the Environmental Protection Regulation 2008.

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

“**existing structure”** means a structure that was in existence prior to the adoption of this schedule of conditions under the authority.

“fill” means any kind of material in solid form (whether or not naturally occurring) capable of being deposited at a place but does not include material that forms a part of, or is associated with, a structure constructed in a watercourse, wetland or spring including a bridge, road, causeway, pipeline, rock revetment, drain outlet works, erosion prevention structure or fence.

“floodplain” has the meaning in the *Water Act 2000* and means an area of reasonably flat land adjacent to a watercourse that:

- is covered from time to time by floodwater overflowing from the watercourse; and
- does not, other than in an upper valley reach, confine floodwater to generally follow the path of the watercourse; and
- has finer sediment deposits than the sediment deposits of any bench, bar or in-stream island of the watercourse.

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

“flowline” is a small diameter pipeline through which fluids move on a petroleum lease before being sold.

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

“hazardous contaminant” means a contaminant that, if improperly treated, stored, disposed of or otherwise managed, is likely to cause serious or material environmental harm because of –

a) its quantity, concentration, acute or chronic toxic effects, carcinogenicity, mutagenicity, corrosiveness, explosiveness, radioactivity or flammability; or

b) its physical, chemical or infectious characteristics.

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

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

“hazard category” means a category, either low significant or high, into which a dam is assessed as a result of the application of tables and other criteria in *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (EM635), prepared by the administering authority, as amended from time to time.

“high bank” - the defining bank is the terrace or bank or, if no bank is present, the point on the active floodplain which confines the average annual peak flows.

“hydraulic performance” means the capacity of a regulated dam to contain or safely pass flowable substances based on a probability (AEP) of performance failure specified for the relevant hazard category in the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (EM635).

"Holder" means:

a) where this document is an environmental authority, any person who is the holder of, or is acting under, that environmental authority; or

b) where this document is a development approval, any person who is the registered operator for that development approval.

"inert demolition and construction waste" means non-putrescible waste arising from construction or demolition activity. It may include materials such as brick, timber, concrete and steel.

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

"LA10, adj, 10 mins" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 10% of any 10-minute measurement period, using Fast response.

"LA1, adj, 10 mins" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 1% of any 10-minute measurement period, using Fast response

"LA, max adj, T" means the average maximum A-weighted sound pressure level, adjusted for noise character and measured over any 10 minute period, using Fast response.

"lake" includes –

a) lagoon, swamp or other natural collection of water, whether permanent or intermittent; and

b) the bed and banks and any other element confining or containing the water.

"land" in the "land schedule" of this document means land excluding waters and the atmosphere.

"land capability" as defined in the DME 1995 Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.

"land suitability" as defined in the DME 1995 Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.

"land degradation" includes the following:

a) soil erosion;

b) rising water tables;

c) the expression of salinity;

d) mass movement by gravity of soil or rock;

e) stream bank instability; and

f) a process that results in declining water quality.

“LA MAX adj T” is the adjusted average maximum A-weighted sound pressure level measured over a time period T. The maxima must be measured on a sound level meter with a frequency weighting that corresponds to perceived loudness (*A* weighting) and the meter must be set to the *fast* response time weighting. The measured values are to be adjusted upwards by 2dB(A) to 5dB(A) if the noise source has tonal characteristics. The measuring period must be in excess of five minutes. The arithmetic average of the adjusted maxima, after eliminating any extraneous noise peaks, is the measure used to characterise the noise environment. (This measure will generally be similar to a percent exceedance of 10% or less. Refer to Australian Standard AS1055.)

“land use” term to describe the selected use of the land, which is planned to occur after the cessation of resource activities.

“leachate” means a liquid that contains soluble, suspended or miscible contaminants likely to have been derived from material which is stored, processed or disposed of on site and which the liquid has passed through or emerged from, or is likely to have passed through or emerged from.

“levee” means a dam, dyke or bund that is designed only to provide for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable substance resulting from unplanned releases from other works of infrastructure, during the progress of those stormwater or flood flows or those unplanned releases; and does not store any significant volume of water or flowable substances at any other times.

“litter” refers to scattered items of rubbish (less than 200 litres), such as cigarette butts, discarded food wrappers and beverage containers.

“licenced waste disposal facility” is a facility approved under a development approval and operated by a holder of a registration certificate for environmentally relevant activity item number 75 under Schedule 1 of the *Environmental Protection Regulation 2008*.

“limited regulated waste” means any of the following regulated wastes, asbestos, clinical waste or quarantine waste that has been rendered non-infectious, fish processing waste, food processing waste, poultry processing waste, tyres or treatment tank sludge or residue produced in the carrying out of an activity in relation to sewage treatment and water supply activities.

“linear infrastructure” means powerlines, pipelines, flowlines, roads and access tracks.

“low consequence dam” means any dam that is not a high or significant consequence category as assessed using the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).

“mandatory reporting level” or **“MRL”** means a warning and reporting level determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (EM635) published by the administering authority.

“manual” means the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (EM635) published by the administering authority.

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

“mg/L” means milligrams per litre.

“mining activity” means

a) an activity that is an authorised activity for a mining tenement under the *Mineral Resources Act 1989*; or

b) another activity that is authorised under the *Mineral Resources Act 1989* that grants rights over land.

"mine affected water":

a) means the following types of water:

  i) pit water, tailings dam water, processing plant water;

  ii) water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the *Environmental Protection Regulation 2008* if it had not formed part of the mining activity;

  iii) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage such runoff, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water;

  iv) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated;

  v) groundwater from the mine's dewatering activities;

  vi) a mix of mine affected water (under any of paragraphs i)-v) and other water;

  vii) associated water, coal seam gas water or produced water from the mine's petroleum activities.

b) does not include surface water runoff which, to the extent that it has been in contact with areas disturbed by resource activities that have not yet been completely rehabilitated, has only been in contact with:

  i) land that has been rehabilitated to a stable landform and either capped or revegetated in accordance with the acceptance criteria set out in the environmental authority but only still awaiting maintenance and monitoring of the rehabilitation over a specified period of time to demonstrate rehabilitation success; or

  ii) land that has partially been rehabilitated and monitoring demonstrates the relevant part of the landform with which the water has been in contact does not cause environmental harm to waters or groundwater, for example:

    1) areas that are been capped and have monitoring data demonstrating hazardous material adequately contained with the site;

    2) evidence provided through monitoring that the relevant surface water would have met the water quality parameters for mine affected water release limits in this environmental authority, if those parameters had been applicable to the surface water runoff; or

    3) both.

"mineral waste" means mining materials resulting from the extraction of coal including overburden, interburden, waste rock and rejects.

"measures" includes any measures to prevent or minimise environmental impacts of the mining activity such as bunds, silt fences, diversion drains, capping, and containment systems.

"NATA" means National Association of Testing Authorities, Australia.

"natural flow" means the flow of water through waters caused by nature.

"nature" includes:

a) ecosystems and their constituent parts; and

b) all natural and physical resources; and

c) natural dynamic processes.

“non-polluting” means having no adverse impacts upon the receiving environment.

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

“noxious” means harmful or injurious to health or physical well-being.

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

“operational land” means the land associated with the project for which this environmental authority has been issued.

“operational plan” includes:

a) normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA allowance); and

b) contingency and emergency action plans including operating procedures designed to avoid and/or minimise environmental impacts including threats to human life resulting from any overtopping or loss of structural integrity of the regulated structure.

“overland flow water” means water, including floodwater, flowing over land, otherwise than in a watercourse or lake:

a) after having fallen as rain or in any other way; or

b) after rising to the surface naturally from underground.

“peak particle velocity (ppv)” means a measure of ground vibration magnitude which is the maximum rate of change of ground displacement with time, usually measured in millimetres/second (mms^{-1}).

“permanent infrastructure” includes any infrastructure (roads, tracks, bridges, culverts, dams, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads, pipelines etc.) which is to be left by agreement with the landowner.

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

“process water” means water used or produced during the mineral development activities.

“Prescribed environmental matters” has the meaning in section 10 of the *Environmental Offsets Act 2014*, and in section 5 of the *Environmental Offsets Regulation 2014*.

“receiving environment” means all groundwater, surface water, land, and sediments that are not disturbed areas authorised by this environmental authority.

“receiving waters” means all groundwater and surface water that are not disturbed areas authorised by this environmental authority.

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

“Register of Regulated structures" includes**:**

a) date of entry in the register;

b) name of the structure , its purpose and intended/actual contents;

c) the consequence category of the structure as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (EM635);

d) dates, names, and reference for the design plan plus dates, names, and reference numbers of all document(s) lodged as part of a design plan for the structure;

e) name and qualifications of the suitably qualified and experienced person who certified the design plan and 'as constructed' drawings;

f) for the regulated structure, other than in relation to any levees –

   i) the dimensions (metres) and surface area (hectares) of the structure measured at the footprint of the structure;

   ii) coordinates (latitude and longitude in GDA94) within five metres at any point from the outside of the dam including its storage area

   iii) dam crest volume (megalitres);

   iv) spillway crest level (metres AHD).

   v) maximum operating level (metres AHD);

   vi) storage rating table of stored volume versus level (metres AHD);

   vii) design storage allowance (megalitres) and associated level of the dam (metres AHD);

   viii) mandatory reporting level (metres AHD);

g) the design plan title and reference relevant to the structure;

h) the date construction was certified as compliant with the design plan;

i) the name and details of the suitably qualified and experienced person who certified that the constructed dam was compliant with the design plan;

j) details of the composition and construction of any liner;

k) the system for the detection of any leakage through the floor and sides of the dams only;

l) dates when the regulated structure underwent an annual inspection for structural and operational adequacy, and to ascertain the available storage volume for 1 November of any year;

m) dates when recommendations and actions arising from the annual inspection were provided to the administering authority;

n) dam water quality as obtained from any monitoring required under this authority as at 1 November of each year.

"regulated dam" means any dam in the significant or high consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)* published by the administering authority.

"regulated waste" means non-domestic waste mentioned in schedule 7 of the *Environmental Protection Regulation 2008* (whether or not it has been treated or immobilised), and includes –

a) for an element – any chemical compound containing the element; and

b) anything that has contained the waste.

"rehabilitation objectives" the end points that rehabilitation aims to achieve. They may be described in terms of future land use, biodiversity values, conservation values, health and safety outcomes, aesthetics or social outcomes or combinations of these.

“rehabilitation indicators” an indicator is something that can be measured and audited according to an established protocol and used to evaluate changes in a system.

“**rehabilitation”** or “**rehabilitated”** means the process of reshaping and revegetating land to restore it to a stable landform and in accordance with acceptance criteria and, where relevant, includes remediation of contaminated land.

“**rejects**” means any of the following from the processing of run-of-mine coal, including any sediment containing hydrocarbons:

a) breaker rejects;

b) coarse rejects;

c) mid/fine size rejects;

d) ultra-fines that have been dewatered; or

e) any combination of rejects under any of paragraphs a to d.

“release” of a contaminant into the environment includes –

a) to deposit, discharge, emit or disturb the contaminant; and

b) to cause or allow the contaminant to be deposited, discharged, emitted or disturbed; and

c) to fail to prevent the contaminant from being deposited, discharged, emitted or disturbed; and

d) to allow the contaminant to escape; and

e) to fail to prevent the contaminant from escaping.

“representative” means a sample set which covers the variance in monitoring or other data either due to natural changes or operational phases of the resource activities.

“Resource activity” is an activity that involves—

(a) a geothermal activity; or

(b) a GHG storage activity; or

(c) a mining activity; or

(d) a petroleum activity.

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

“riverine area” refers to the land confined to the flood flow channel of a watercourse.

“Run of mine (ROM) coal” means raw coal which has been extracted as part of the mining activities and has not been subject to any form of processing, crushing, screening or washing.

“saline drainage” The movement of waters, contaminated with salt(s), as a result of the mining activity.

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

"sensitive place" means:

a) a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or

b) a motel, hotel or hostel; or

c) an educational institution; or

d) a medical centre or hospital; or

e) a protected area under the *Nature Conservation Act 1992*, the *Marine Parks Act 1992* or a World Heritage Area; or

f) a public park or gardens.

"sewage" means the used water of person's to be treated at a sewage treatment plant.

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

"significant residual impact" has the meaning in section 8 *Environmental Offsets Act 2014.*

"significantly disturbed" or **"significant disturbance"** or **"significant disturbance to land or areas"** has the meaning in Schedule 12, section 4 of the *Environmental Protection Regulation 2008*. Land is significantly disturbed if—

a) it is contaminated land; or

b) it has been disturbed and human intervention is needed to rehabilitate it—

   i) to a condition required under the relevant environmental authority; or

   ii) if the environmental authority does not require the land to be rehabilitated to a particular condition—to the condition it was in immediately before the disturbance.

"site" means the area within the petroleum authority or authorities to which the environmental authority relates.

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

"spring" means the land to which the water rises naturally from below the ground and the land over which the water then flows.

"stable" has the meaning in Schedule 5 of the *Environmental Protection Regulation 2008* and, for a site, means the rehabilitation and restoration of the site is enduring or permanent so that the site is unlikely to collapse, erode or subside.

"storm water" means all surface water runoff from rainfall.

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

"suitably qualified and experienced person" in relation to dams means one who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act 1988*, OR registered as a National Professional Engineer (NPER) with the Institution of Engineers Australia, OR holds equivalent professional qualifications to the satisfaction of the administering authority for the Act; AND the administering authority for the Act is satisfied that person has knowledge, suitable experience and demonstrated expertise in relevant fields, as set out below:

a) knowledge of engineering principles related to the structures, geomechanics, hydrology, hydraulics, chemistry and environmental impact of dams; and

b) a total of five years of suitable experience and demonstrated expertise in at least four of the following categories, with the ‘geomechanics of dams’ category being compulsory:

i) geomechanics of dams with particular emphasis on stability, geology and geochemistry.

ii) investigation, design or construction of dams.

iii) operation and maintenance of dams.

iv) hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology.

v) hydraulics with particular reference to sediment transport and deposition, erosion control, beach processes.

vi) hydrogeology with particular reference to seepage, groundwater.

vii) solute transport processes and monitoring thereof.

viii) dam safety.

“synthetic based drilling mud” means a mud where the base fluid is a synthetic oil, consisting of chemical compounds which are artificially made or synthesised by chemically modifying petroleum components or other raw materials rather than the whole crude oil

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

“top soil” means the top layer of soil, alluvium or weathered rock that forms a suitable plant growth medium. Top soil should be non-crusting and low in salinity.

“trivial harm” means environmental harm which is not material or serious environmental harm and will not cause actual or potential loss or damage to property of an amount of, or amounts totalling more than $5,000.

“void” means any man-made, open excavation in the ground.

“waste” as defined in section 13 of the *Environmental Protection Act 1994*.

“waste and resource management hierarchy” has the meaning given by the *Waste Reduction and Recycling Act 2011*.

“water” means –

a) water in waters or spring;

b) underground water;

c) overland flow water; or

d) water that has been collected in a dam.

“watercourse” means a watercourse as defined under Chapter 2 of the *Water Act 2000*.

“waterlogging” is the saturation of soil by soil water.

“waste water” means used water from the activity, process water or contaminated storm water.

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

“waters” includes –

a) river, creek, stream in which water flows permanently or intermittently either:

   i) in a natural channel, whether artificially improved or not; or

   ii) in an artificial channel that has changed the course of the river, creek or stream; or

b) lake, lagoon, pond, swamp, wetland, dam; or

c) unconfined surface water; or

d) storm water channel, storm water drain, roadside gutter; or

e) bed and banks and any other element of a river, creek, stream, lake, lagoon, pond, swamp, wetland, storm water channel, storm water drain, roadside gutter or dam confining or containing water; or

f) groundwater; or

g) non-tidal or tidal waters (including the sea); or

h) any part-thereof.

“water year” means the 12-month period from 1 July to 30 June. “**watercourse” -** means a river, creek or stream in which water flows permanently or intermittently in a visibly defined channel (natural, artificial or artificially improved) with:

(a) continuous bed and banks;

(b) an extended period of flow for some months after rain ceases, and

(c) an adequacy of flow that sustains basic ecological processes and maintains biodiversity.

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

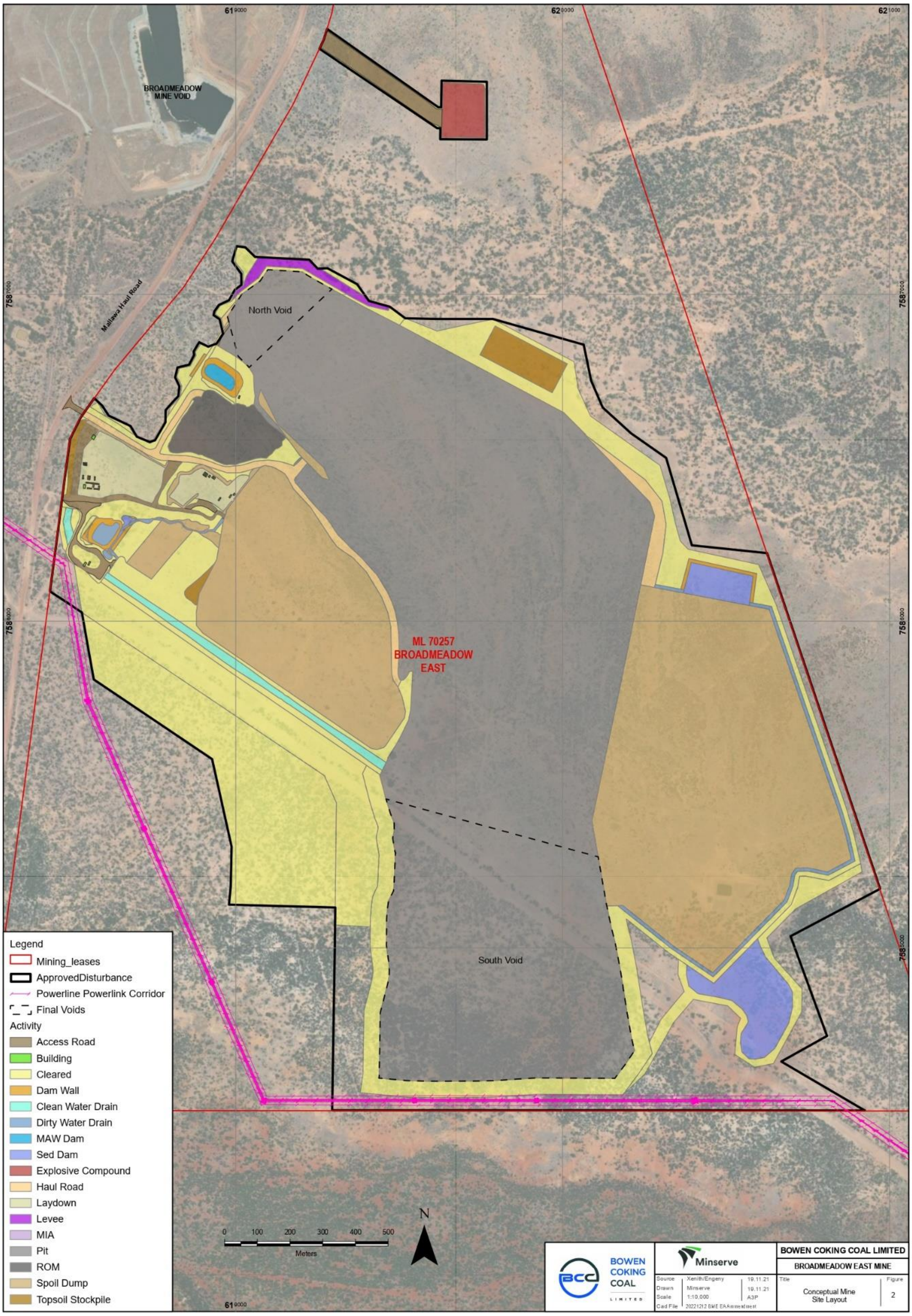
“wet season” means the time of year, covering one or more months, when most of the average annual rainfall in a region occurs. For the purposes of DSA determination this time of year is deemed to extend from 1 November in one year to 31 May in the following year inclusive.

“wetland” means an area shown as a wetland on a ‘Map of referable wetlands’, a document approved by the chief executive (environment). A map of referable wetlands can be viewed at www.ehp.qld.gov.au.

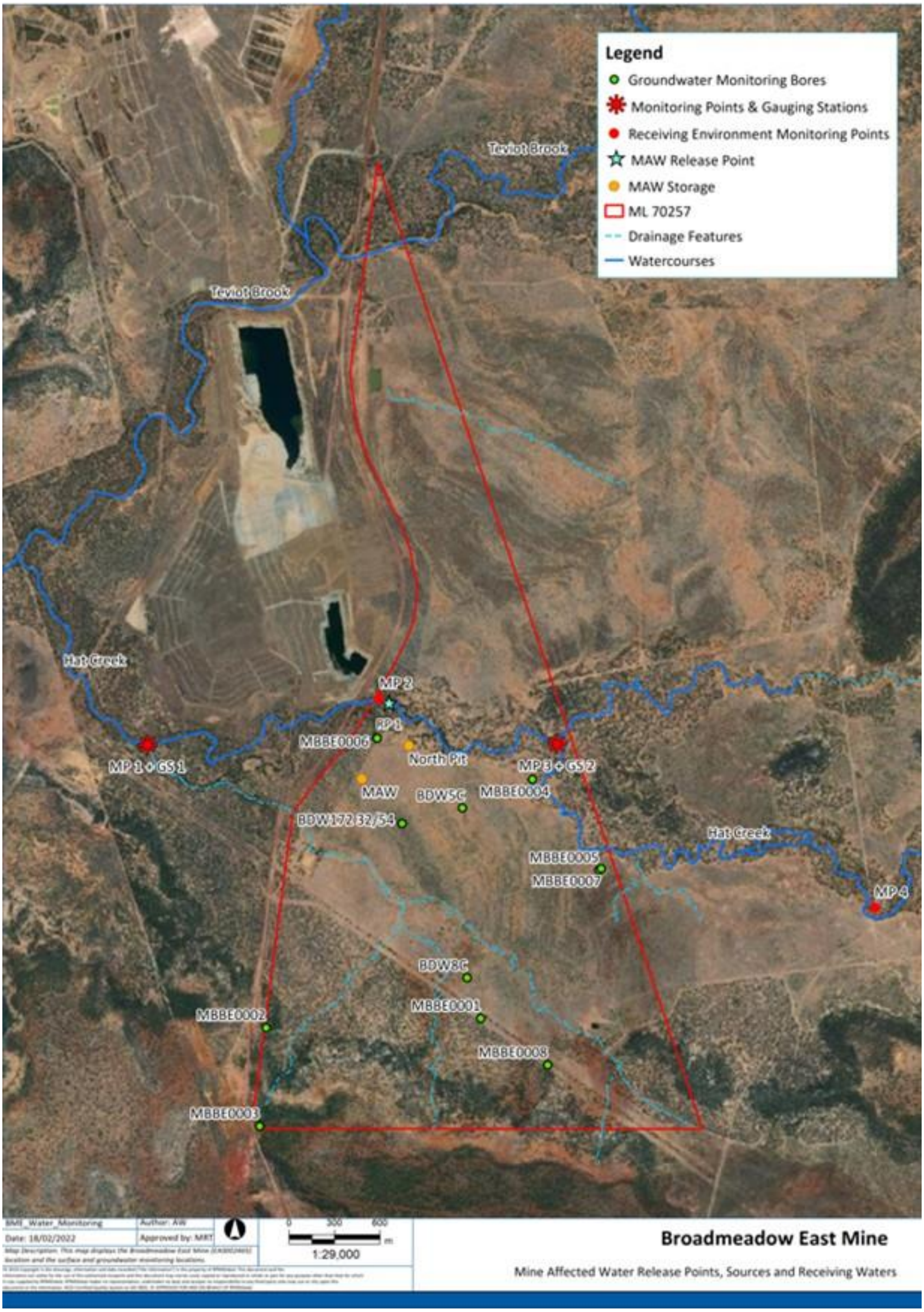
“μg/L” means micrograms per litre.

Appendix 1 Figure 1 – Disturbance Map

Appendix 2 Figure 2 – Mine Plan



Appendix 3 Figure 3 – Mine affected water release points and monitoring locations



Appendix 4 Figure 4 – Final landform, post closure

Appendix 5

Table G1 Post Mine Land Use (PMLU) and Rehabilitation Methods

Disturbance Area (DA)	Description	Pre-Mining Land Suitability Class		Rehabilitation Method	PMLU	Post-Mining Land Suitability Class	
		Cattle Grazing	Rainfed Broadacre Cropping			Cattle Grazing	Rainfed Broadacre Cropping
1. Out of Pit dumps (OOPD)	Two OOPDs border the eastern and western boundaries of the pit area.	4 &5	4 &5	▪ Confirm the engineering and design final landform plans with associated QA/QC methods. ▪ Bulk earthworks to achieve required landform and slopes as per design and proposed methods within the Environmental Management System (EMS). ▪ 5m capping of any rejects stored in the OOPD with overburden that is non-reactive (geochemically and physically inert). ▪ General reshaping and pushing/trimming to achieve final landform. ▪ Fill in associated sediment dams when no longer required as per updated Erosion and Sediment Control Plan (ESCP). ▪ Install long term erosion and sediment control systems/features as per closure ESCP based on achieved groundcover and landform stability. ▪ Remediate subsidence and erosion before sourcing, delivering, and spreading growth media. ▪ Apply ameliorants and fertilisers to growth media before and after application (based on QA/QC process). ▪ Trim/rip, apply seeding and irrigate. ▪ If possible, rehabilitation trials on areas that have been progressively rehabilitated. ▪ Monitoring and reporting as per Rehabilitation Monitoring Program required under **Condition G15.**	Low-intensity grazing	4	4
2. Northern Pit	The residual void created at the start of the pit development and used for bulk water storage over the	4	4	▪ Dewater (for use in dust suppression) prior to rehab. ▪ Backfill to 270 RL.	Low-intensity grazing	4	4

Disturbance Area (DA)	Description	Pre-Mining Land Suitability Class		Rehabilitation Method	PMLU	Post-Mining Land Suitability Class	
		Cattle Grazing	Rainfed Broadacre Cropping			Cattle Grazing	Rainfed Broadacre Cropping
	operational mine life. Borders the central backfilled void. The final depth will be backfilled to 270 RL (above groundwater levels post closure).			▪ Reshaping, trimming and construction of long-term drainage/ESC. ▪ Cover exposed coal seams with 2 or more meters of NAF material. Develop specific rehabilitation strategies that includes monitoring, surveying, stability analysis and reporting.			
3. Central backfilled Pit	Central portion of the previously active pit area that is backfilled as the resource is extracted and the mining moves in a southern direction. The area will be backfilled to a final height of 310 RL (above groundwater level post closure).	4 &5	4 &5	▪ Conduct long term water balance studies regarding void hydrology that includes surface water and groundwater assessments. ▪ A suitably qualified person to conduct a geotechnical assessment of the final landform. ▪ A suitably qualified person to conduct an assessment of hydraulic properties of the backfilled material to ascertain potential for instability. ▪ Update flood modelling according to final design, geochemical and stability assessments. ▪ General reshaping and pushing/trimming to achieve final landform. ▪ 5m capping of any rejects stored in the central backfilled pit with overburden that is non-reactive (geochemically and physically inert). ▪ Rejects are buried above the expected (post-closure) groundwater level. ▪ Fill in associated sediment dams. ▪ Install long term erosion and sediment control systems/features. ▪ Remediate subsidence and erosion before sourcing, delivering, and spreading growth media. ▪ Apply ameliorants and fertilisers to growth media before and after application (based on QA/QC process). ▪ Trim/rip, apply seeding and irrigate. ▪ If possible, rehabilitation trials. ▪ Monitoring and reporting.	Low-intensity grazing	4	4

Disturbance Area (DA)	Description	Pre-Mining Land Suitability Class		Rehabilitation Method	PMLU	Post-Mining Land Suitability Class	
		Cattle Grazing	Rainfed Broadacre Cropping			Cattle Grazing	Rainfed Broadacre Cropping
4. Southern Void	The residual void remaining post mining at the southern pit extent. Borders the central backfilled void	4 &5	4	▪ Minimised void area and volume based on economic, engineering, geotechnical, geochemical, surface water and groundwater technical reporting outcomes (Condition G8). ▪ Design final slope angles of the high, low and end walls. ▪ Conduct long term water balance studies regarding void hydrology that includes surface water and groundwater assessments. ▪ Create a final void design plan. Predict long term water quality through geochemical modelling. ▪ Manage long term water quality for livestock consumption as per Australian and New Zealand Guidelines for Fresh and Marine Water Quality (the Guidelines). ▪ Backfill above the regional groundwater level, treat or remove exposed coal seams. ▪ Develop specific rehabilitation strategies that includes monitoring, surveying, stability analysis and reporting.	Water storage	4 (Low wall slopes)	N/A
5. Water management infrastructures.	Water infrastructure includes: 1. Existing farm dam at the northern tip of the ML which will remain post closure as per the existing landholder agreement (to remain post closure). 2. Five sediment dams (rehabilitation at closure). 3. One clean water dam. (Rehabilitation at closure) 4. One MAW dam (rehabilitation at closure).	4	4	▪ Conduct land contamination investigation. ▪ Remove fencing and signage. ▪ Dewater (for use in dust suppression) prior to rehab if applicable. ▪ Remove the top 250 mm of sediment and burry it. ▪ General reshaping and pushing/trimming to achieve final landform. ▪ Trim/rip, apply seeding and irrigate. ▪ Monitoring and reporting.	Low-Intensity Grazing	4	4

Disturbance Area (DA)	Description	Pre-Mining Land Suitability Class		Rehabilitation Method	PMLU	Post-Mining Land Suitability Class	
		Cattle Grazing	Rainfed Broadacre Cropping			Cattle Grazing	Rainfed Broadacre Cropping
	5. North pit flood diversion levee (A regulated structure). 6. North-eastern levee (integrated into the final landform). 7. Five groundwater monitoring bores will remain until the completion of the post closure monitoring program.						
6. Mining Industrial Area (MIA), explosives storage area and exploration	Workshops, ROM, offices, waste, explosives and chemical storage.	4	4	▪ Remove buildings. ▪ Disconnect services, empty tanks, and licenced removal of contaminated water. ▪ Remove and proper disposal of road surface and fencing. ▪ Rehabilitate remaining boreholes not required for post closure monitoring. ▪ Conduct contaminated land investigation and remediate any contaminated soils. ▪ Remove and properly dispose of general and regulated waste. ▪ Remove imported fill used to raise MIA (treat as contaminated) and encapsulate in backfilled pit or open waste dumps.	Low-intensity grazing	4	4
7. Roads, tracks and cleared areas	Internal roads, tracks and cleared areas associated with haulage, site and powerline access.	4 &5	4 &5	▪ Remove signage and other non-permanent markers. ▪ General reshaping and pushing trimming to achieve pre-disturbance contours (including re-establishment of bed and banks). ▪ Installation of long terms erosion and sediment control systems where required. ▪ Source, cart and spread growth media. ▪ Rip and seed. ▪ Monitoring and reporting.	Low-intensity grazing	4	4

Table G2 PMLU and rehabilitation success criteria

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
1 Out of Pit Dumps					
Low intensity Grazing	Out of Pit Dumps	Safe	Safety hazards in rehabilitation are similar to surrounding unmined landscapes	Hazard assessment by a suitably qualified and experienced person	Risk is as low as reasonably practical (ALARP) in accordance with *AS/NZS ISO 31000:2009 Risk Management.*
		Stable	a. Landform development and reshaping/re-profiling b. Surface preparation. c. Structurally sound with no major slumping. d. No exposed hazardous material. e. No major erosion.	Outer slopes: ▪ 15% as per landform design. ▪ Vertical distance between berms: 20 m ▪ Berm width: 5 m ▪ Drainage outward away from void towards original topo drainage paths. Inner slopes (into full backfill area): ▪ 12% as per landform design. ▪ Vertical distance between berms: 20 m ▪ Berm width: 5 m ▪ Drainage outward away from void towards original topo drainage paths. Subsidence ▪ Subsidence monitored pre and post wet season and addressed accordingly. Factor of Safety ▪ Geotechnical adequacy with 1.5 Factor of Safety.	▪ Certification from an AQP that the area has achieved stable condition. ▪ All rehabilitated areas are geo-technically stable for the intended post mining grazing land use, with no active areas of rill or gully erosion, and; drainage follows appropriate drainage paths.
		Non-polluting	a. Surface Run off is minimised and is non-polluting to land and receiving waters[1] b. No environmental harm.	**Receiving environment contaminant limit** - ○ pH – 6.5-8.5 ○ EC - baseflow 720 µS/cm[a] ○ high flow 250 µS/cm[b] ○ Turbidity - 50 NTU ○ Arsenic – 13 µg/L ○ Molybdenum – 0.15mg/L ○ Selenium – 5 µg/L	▪ Assessment of soil health and suitability has been completed by an AQP. ▪ Receiving water quality indicators do not exceed specified criteria limits ▪ Groundwater monitoring demonstrates that the

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
				○ Sulfate - 25 mg/L ○ Suspended solids - 55 mg/L[b] ▪ Groundwater aquifers maintain their pre-mining or reference bore water quality. ▪ Erosion rate of <5 t/ha/yr and 10.0 t/ha/yr as determined by landform design. ▪ The installation of certified contours and drains as per design by an AQP (CPESC). ▪ 5m capping of rejects within OOPD with overburden that is non-reactive (geochemically and physically inert).	groundwater quality is within 95th percentile of the results of baseline pre-mining bore monitoring results, or when baseline is not available, reference bores which have not been impacted by mining activities. ▪ Certification by an AQP that rejects are buried under geochemically and physically inert overburden with a minimum cover thickness of 5m.

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
		Self-Sustaining	a. Adequate revegetation. b. Ameliorate spoil as required to a depth of a minimum of 200 mm to suitably stabilise the landform and c. promote vegetative establishment.	▪ Groundcover 60% perennial pasture biomass. ▪ Less than 5% of declared weeds (excluding Parthenium weed- *Parthenium hysterophorus)* ▪ Land Class suitability 4 for grazing. ▪ Abundance of declared weeds is less than reference sites. ▪ No active areas of rill or gully erosion and drainage follows the appropriate drainage paths. ▪ Resilience to fire and drought. ▪ Soil nutrient concentrations and nutrient cycling comparable to reference sites.	▪ Results, that rehabilitated areas meet the land suitability assessment that meets class 4 for cattle grazing as defined by the Guideline for Agricultural Land Evaluation in Queensland (State Department of Queensland 2015). ▪ Certification of less than 5% declared weed and pest species identified in rehabilitated areas ▪ Post closure flora and fauna monitoring as per the monitoring plan.
Northern pit (Partial Backfill)					
Low intensity grazing	Northern pit (Partial Backfill)	Safe	a. Safety hazards in rehabilitation are similar to surrounding unmined landscapes b. Provide a safe landscape for humans and animals post closure.	▪ Hazard assessment by a suitably qualified and experienced person ▪ Backfill level (water level based on groundwater conceptual modelling): 270RL ▪ No access to steep zones through the construction of safety bunds at 2 m high, base width of 5 m from unweathered, freely draining, end-dumped rockfill at a minimum 20 m offset from the depression perimeter as per the void closure plan.	Risk is as low as reasonably practical (ALARP) in accordance with *AS/NZS ISO 31000:2009 Risk Management.*

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
		Stable	Stabilise walls and slopes.	▪ Final shape implemented as per rehabilitation and management strategies included in the void closure plan. ▪ Partial backfill according to appropriate groundwater level and as per the methods and techniques from the void closure plan. ▪ Slopes less than 20%., to be re-assessed and designed as per the chemical and physical characteristics of the site ▪ Geotechnical adequacy with 1.5 Factor of Safety. ▪ Structural, geotechnical and hydraulic factors based on the physical and chemical characteristics of the site. ▪ Spoil shaped to connect to the surrounding landscape where possible. ▪ No active erosion or gullies.	▪ Geotechnical report and certification from an AQP that the area has achieved stable condition as per the criteria.
		Non-polluting	Surface Run off or any discharge, seepage is non-polluting to land, surface water[1] and ground water	▪ Removal of all mine affected water for use in dust suppression prior to backfilling. ▪ Removal of potential contaminated sediments that may be identified in the land contamination survey. ▪ The installation of certified contours and drains as per design by an AQP (CPESC). **Receiving environment contaminant limit** - ○ pH – 6.5-8.5 ○ EC - baseflow 720 µS/cm[a] ○ high flow <250 µS/cm[b] ○ Turbidity - 50 NTU ○ Arsenic – 13 µg/L	▪ Land contamination survey results. ▪ Groundwater monitoring demonstrates that the groundwater quality is within 95th percentile of the results of baseline pre-mining bore monitoring results, or when baseline is not available, reference bores which have not been impacted by mining activities. ▪ Certification by an AQP that the groundwater level and

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
				○ Molybdenum – 0.15mg/L ○ Selenium – 5 µg/L ○ Sulfate - 25 mg/L ○ Suspended Solids - 55 mg/L[b] ▪ Groundwater aquifers maintain their pre-mining or reference bore water quality. ▪ Prescribed environmental matters maintain their pre-mining condition ▪ Coal seams will be removed or covered in the backfilling process. ▪ No exposed hazardous material.	quality will not cause harm to the surrounding environment. ▪ Receiving water quality indicators do not exceed specified criteria limits.
		Self-sustaining	a. Adequate revegetation and aquatic species richness. b. Littoral zone increases and linkages with terrestrial vegetation.	▪ Battered slopes with 60% perennial pasture biomass as per the closure and revegetation plans. ▪ Land Class 4 for grazing. ▪ Less than 5% of declared weeds (excluding Parthenium weed- *Parthenium hysterophorus)* ▪ Resilience to fire and drought. ▪ Grazing vegetation resilient to disease, drought and fire. ▪ Soil nutrient concentrations, nutrient cycling and vegetation diversity and cover comparable to reference sites. ▪ -Establishment of a mix of perennial grasses suitable for grazing in the area.	▪ Results, that rehabilitated areas meet the land suitability assessment that meets class 4 for cattle grazing as defined by the Guideline for Agricultural Land Evaluation in Queensland (State Department of Queensland 2015). ▪ Post closure flora and fauna ecological monitoring as per the monitoring plan.
Central Pit (full backfill)					
Grazing	Central Pit (full backfill)	Safe	Safety hazards in rehabilitation are similar to surrounding unmined landscapes	Hazard assessment by a suitably qualified and experienced person	Risk is as low as reasonably practical (ALARP) in accordance with *AS/NZS ISO 31000:2009 Risk Management.*

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
		Stable	▪ Landform development and reshaping/re-profiling. Hydraulic assessment conducted to determine instability from floodwaters. ▪ Surface preparation.	▪ Contoured to the surrounding topography as per landform design. ▪ Subsidence monitored pre and post wet season and addressed accordingly. ▪ Slopes less than 20% ▪ Geotechnical adequacy with 1.5 Factor of Safety ▪ Final shape implemented as per rehabilitation and management strategies included in the void closure plan.	▪ Certification from an AQP that the area has is geotechnically stable condition.
		Non-polluting	Surface run off is minimised and is non-polluting to land and receiving waters[1]	▪ Maximum erosion rate of <5 t/ha/yr and 10.0 t/ha/yr as determined by landform design. ▪ The installation of certified contours and drains as per design by an AQP (CPESC). ▪ Drainage outward away from void towards and/original topo drainage paths. **Receiving environment contaminant limit** - ○ pH – 6.5-8.5 ○ EC - baseflow 720 µS/cm[a] ○ high flow <250 µS/cm[b] ○ Turbidity - 50 NTU ○ Arsenic – 13 µg/L ○ Molybdenum – 0.15mg/L ○ Selenium – 5 µg/L ○ Sulfate - 25 mg/L ○ Suspended Solids - 55 mg/L[b] ▪ Groundwater aquifers maintain their pre-mining or reference bore water quality. ▪ Groundwater quality as per the water management plan.	▪ Contaminated land survey conducted by an AQP to ensure there is no contamination that will prohibit the establishment of the PMLU. ▪ Receiving water quality indicators do not exceed specified criteria limits ▪ Groundwater monitoring demonstrates that the groundwater quality is within 95th percentile of the results of baseline pre-mining bore monitoring results, or when baseline is not available, reference bores which have not been impacted by mining activities. ▪ Certification by an AQP that rejects are buried under geochemically and

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
				▪ Coal seams to be treated, removed or covered in the backfilling process. ▪ 5m capping of rejects within central backfilled pit with overburden that is non-reactive (geochemically and physically inert).	physically inert overburden with a minimum cover thickness of 5m.
		Self-sustaining	Adequate revegetation and connectivity to the surrounding landscape including into the final voids.	▪ Groundcover is 60% perennial pasture biomass as per the revegetation plan. ▪ Land Class 4 for grazing. ▪ Less than 5% of declared weeds (excluding Parthenium weed- *Parthenium hysterophorus)*. ▪ No active areas of rill lor gully erosion and drainage follows the appropriate drainage paths. ▪ Resilience to fire and drought.	▪ Results, that rehabilitated areas meet the land suitability assessment that meets class 4 for cattle grazing as defined by the Guideline for Agricultural Land Evaluation in Queensland (State Department of Queensland 2015). ▪ Certification that less than 5% of weed and pest species identified in Rehabilitation Areas Post closure flora and fauna monitoring as per the monitoring plan.
Southern Void					
Water storage	Southern Void	Safe Stable	a. Safety hazards in rehabilitation are as low as reasonably practical. b. Minimise void area. c. Stabilise walls and slopes.	▪ Install slopes and batters as per the void closure plan: ○ Overall slope: 15% ○ Vertical distance between berms: 20 m ○ Berm width: 5 m ○ Final pit walls (Competent material): 70 degrees ○ Final pit walls (Incompetent material): 45 degrees ○ Underwater slopes: Angle of repose 37 degrees ○ Void maximum surface area (31 ha).	▪ Geotechnical report and certification from an appropriately qualified and experienced person AQP that the area has achieved stable condition, including: ▪ Safety bund constructed in accordance with engineering

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
				○ Void maximum depth (105 m). ○ Maximum Void lake equilibrium level will not reach 300 m AHD. ○ Drainage direction: into the void ○ Backfill above the groundwater level (water level based on conceptual modelling). ▪ Safety bund constructed at 2 m high, base width of 5 m from unweathered, freely draining, end-dumped rockfill at a minimum 20 m offset from the pit perimeter as per the closure plan. ▪ Design the void as per the void closure plan. ▪ Final shape implemented as per rehabilitation and management strategies included in the void closure plan. ▪ Partial backfill according to above the groundwater level and as per the baseline groundwater assessment.	requirements for height, based on crest width. ▪ No public access to high wall or end wall areas. ▪ Fence entire perimeter and bund to high wall areas. ▪ Absence of active rill/gully erosion ▪ Certification that drainage measures and structures have been appropriately established and are directing overland flow away from the highwall edge; and ▪ Certification that erosion and sediment control measures have been installed and are operating as designed ▪ Final void located outside of the Isaac River floodplain, as defined under the *Environmental Protection Act*. ▪ Evidence, which has been certified by an appropriately qualified person, based on up to date groundwater modelling, that any final void lakes will not overflow nor potentially contaminate any

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
					other surface water bodies and groundwater aquifers.
		Non-polluting	Pit waters are contained such that they do not impact or interact surface or groundwater.	▪ Coal seams to be treated, removed or covered in the backfilling process. ▪ The installation of certified contours and drains as per design by an AQP (CPESC). ▪ Surface water quality of the receiving environment as per the water management plan. ▪ Groundwater aquifers maintain their pre-mining or reference bore water quality. ▪ Prescribed environmental matters maintain their pre-mining condition ▪ Groundwater quality as per the closure water management plan. ▪ No exposed hazardous material. ▪ Conduct a water balance study to assess the void surface and groundwater interactions. ▪ Predict long term water quality for the overall final void system.	▪ Surface water and groundwater trigger limits assessed as per the frequencies noted in the closure water management plan. ▪ Certification by an AQP that the water level and quality will not cause harm to the surrounding environment. ▪ Groundwater monitoring demonstrates that the groundwater quality is within 95th percentile of the results of baseline pre-mining bore monitoring results, or when baseline is not available, reference bores which have not been impacted by mining activities.
		Self-sustaining	a. Adequate revegetation and aquatic species richness. b. Littoral zone increases and linkages with terrestrial vegetation.	▪ Battered slopes with 60% vegetation cover as per the closure and revegetation plans. ▪ Structural, geotechnical and hydraulic factors based on the physical and chemical characteristics of the site. ▪ Spoil shaped to connect to the surrounding landscape where possible. ▪ No active erosion.	Post closure aquatic, flora and fauna ecological monitoring as per the monitoring

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
				▪ Water quality suitable for stock watering as per Australian and New Zealand Guidelines for Fresh and Marine Water Quality (the Guidelines).	
Water management Infrastructure (to be rehabilitated)					
Low intensity grazing	Water management infrastructure Includes: 1. Four sediment dams (rehabilitation at closure). 3. One clean water dam. 4. One MAW dam 5. North pit flood diversion levee. 6. North-eastern levee (integrated into the final landform if not required). 7. Five groundwater monitoring bores will remain until the completion of the post closure monitoring program.	Safe	Safety hazards in rehabilitation are similar to surrounding unmined landscapes	Hazard assessment by a suitably qualified and experienced person	Risk is as low as reasonably practical (ALARP) in accordance with *AS/NZS ISO 31000:2009 Risk Management.*
		Stable	a. Dewatering and landform profiling in line with surrounding topography. b. Surface preparation.	Subsidence and erosion are monitored and addressed. 60% perennial pasture groundcover is achieved.	▪ Progressive rehabilitation certification under the EP Act. ▪ Contaminated land survey conducted by an AQP to ensure there is no contamination that will prohibit the establishment of the PMLU. ▪ Receiving water quality indicators do not exceed specified limits ▪ Groundwater monitoring demonstrates that the groundwater quality is within 95th percentile of the results
		Non-polluting	a. Desilting 200m. b. Land investigations. c. Surface run off is minimised and is non-polluting to land and receiving waters[1]	**Receiving environment contaminant limit** - ○ pH – 6.5-8.5 ○ EC - baseflow 720 µS/cm[a] ○ high flow <250 µS/cm[b] ○ Turbidity - 50 NTU ○ Arsenic – 13 µg/L ○ Molybdenum – 0.15mg/L ○ Selenium – 5 µg/L ○ Sulfate - 25 mg/L ○ Suspended Solids - 55 mg/L[b]	
		Self-sustaining	Adequate revegetation.		

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
				▪ Groundwater aquifers maintain their pre-mining or reference bore water quality. ▪ Groundcover is 60% perennial pasture biomass as per the revegetation plan. ▪ Land Class 4 for grazing. ▪ Less than 5% of declared weeds (excluding Parthenium weed- *Parthenium hysterophorus)*. ▪ No active areas of rill or gully erosion and drainage follows the appropriate drainage paths. ▪ Resilience to fire and drought.	of baseline pre-mining bore monitoring results, or when baseline is not available, reference bores which have not been impacted by mining activities. ▪ Certification that less than 5% of weed and pest species identified in Rehabilitation Areas. ▪ Results, that rehabilitated areas meet the land suitability assessment that meets class 4 for cattle grazing as defined by the Guideline for Agricultural Land Evaluation in Queensland (State Department of Queensland 2015). ▪ Post closure flora and fauna monitoring as per the monitoring.
Water management Infrastructure (to be retained)					
Water storage (above ground landholder dam to be retained)	Water infrastructure 1. Existing farm dam at the northern tip of the ML which will remain post closure as per the existing landholder	Safe	a. Fencing in place where appropriate in consultation with the landholder b. Surface preparation. c. Landholder accepts the condition of the	Subsidence and erosion are monitored and addressed.	Contaminated land survey conducted by an AQP to ensure there is no contamination that will prohibit the establishment of the PMLU.
		Stable		Area adequately accessible to livestock.	

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
	agreement (to remain post closure). 2. Sediment Dam 4 (southeast).		infrastructure including its structural integrity.		
		Non-polluting	a. Water quality sampling. b. Desilting 200m. c. Land investigations.	Farm dam water quality must be suitable for release into watercourse in compliance with the EA prior to surrender (as per Section 1.3 of the current agreement).	
		Self-sustaining	Structurally sound at the time of handover.	No active areas of rill or gully erosion and drainage follows the appropriate drainage paths.	
MIA/Exploration/Explosives					
Grazing	MIA/exploration/ Explosives	Safe Stable	a. Landform profiling in line with surrounding topography. b. All exploration drill holes have been rehabilitated. c. Drill holes grouted and casings cut to ground level. d. Surface preparation.	▪ 'Requirements for Water Bores in Australia' (Australian Government, February 2012) or latest edition. ▪ No active erosion rills or gullies present. ▪ 60% groundcover of perennial pasture biomass is achieved.	▪ Progressive rehabilitation certification under the EP Act. ▪ All exploration drill holes have been rehabilitated in accordance with the applicable Australian Standard or guideline. ▪ Certification that less than 5% of weed and pest species identified in Rehabilitation Areas.
		Non-polluting	a. All services disconnected, buildings and infrastructure removed. b. Contaminated soil identified and removed in	**Receiving environment contaminant limit** - ○ pH – 6.5-8.5 ○ EC - baseflow 720 µS/cm[a] ○ high flow <250 µS/cm[b] ○ Turbidity - 50 NTU ○ Arsenic – 13 µg/L ○ Molybdenum – 0.15mg/L ○ Selenium – 5 µg/L	▪ Contaminated land survey conducted by an AQP to ensure there is no contamination that will prohibit the establishment of the PMLU.

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
			accordance with relevant guidelines and standards. c. Surface run off is non-polluting to land and receiving waters[1]	○ Sulfate - 25 mg/L ○ Suspended Solids - 55 mg/L[b] ▪ Wastes are managed according to waste and resource management hierarchy. ▪ No exposed hazardous materials at surface determined by results of site contaminated land investigation including exposure due to erosion.	▪ Receiving water quality indicators do not exceed specified criteria limits
		Self-sustaining	Adequate revegetation.	▪ Groundcover is 60% perennial pasture cover/ biomass ▪ Land Class 4 for grazing ▪ Less than 5% of declared weeds (excluding Parthenium weed- *Parthenium hysterophorus)* ▪ No active areas of rill or gully erosion and drainage follows the appropriate drainage paths. ▪ Resilience to fire and drought. ▪ Soil nutrient concentrations and nutrient cycling comparable to reference sites.	▪ Certification that less than 5% of declared weed and pest species identified in Rehabilitation Areas. ▪ Post closure flora and fauna monitoring as per the monitoring plan. ▪ Results, that rehabilitated areas meet the land suitability assessment that meets class 4 for cattle grazing as defined by the Guideline for Agricultural Land Evaluation in Queensland (State Department of Queensland 2015).
Roads, tracks and cleared areas					
Grazing	Roads, tracks and cleared areas	Safe Stable	a. Landform profiling in line with surrounding topography. b. Surface preparation.	▪ Subsidence and erosion are monitored and addressed. ▪ 60% perennial pasture groundcover is achieved.	▪ Progressive rehabilitation certification under the EP Act. ▪ Contaminated land survey conducted by an AQP to

PMLU	DA	Goals	Objectives/Indicators	Criteria	Validation Method
		Non-polluting	a. Signage and fencing removed. b. Contaminated soil identified and removed in accordance with relevant guidelines and standards.	▪ Surface water quality of the receiving environment as per the water management plan. ▪ Land Class 4 for grazing. ▪ Less than 5% of declared weeds (excluding Parthenium weed- *Parthenium hysterophorus)*. ▪ Abundance of declared weeds is less than reference sites. ▪ No active areas of rill lor gully erosion and drainage follows the appropriate drainage paths. ▪ Resilience to fire and drought.	ensure there is no contamination that will prohibit the establishment of the PMLU. ▪ Receiving water quality indicators do not exceed limits specified in Table C2. ▪ Certification that less than 5% of declared weed and pest species identified in Rehabilitation Areas. ▪ Post closure flora and fauna monitoring as per the monitoring plan. ▪ Results, that rehabilitated areas meet the land suitability assessment that meets class 4 for cattle grazing as defined by the Guideline for Agricultural Land Evaluation in Queensland (State Department of Queensland 2015).
		Self-sustaining	Adequate revegetation.		

END OF ENVIRONMENTAL AUTHORITY

Klohn Crippen Berger

Bowen Coaking Coal

BME Progressive Rehabilitation and Closure Plan

Groundwater Report

Final

ISO 9001 14001 45001

DX70025A06

September 2023

27 September 2023

Bowen Coking Coal Limited
Level 4, 167 Eagle Street
Brisbane, Queensland
4000

Melinda Bergmann
Principal Environmental Advisor

Dear Ms Bergmann:

BME Progressive Rehabilitation and Closure Plan
Groundwater Report
Final

KCB Australia Pty Ltd is pleased to provide this final report for the Broadmeadows East Draft Progressive Rehabilitation and Closure Plan (PRCP). Should you have any queries, please do not hesitate to contact the undersigned.

Yours truly,

KCB AUSTRALIA PTY LTD.

Carly Waterhouse
Senior Hydrogeologist, Project Manager

CW:JJ

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CLARIFICATIONS REGARDING THIS REPORT

This report is an instrument of service of Klohn Crippen Berger (KCB). The report has been prepared for the exclusive use of Bowen Coking Coal (Client) for the specific application to the BME Progressive Rehabilitation and Closure Plan, and it may not be relied upon by any other party without KCB's written consent.

KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

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1 INTRODUCTION

KCB Australia Pty Ltd (KCB) have been commissioned by Coking Coal One Pty Ltd (CCO), a wholly owned subsidiary of Bowen Coking Coal Limited (BCC), to complete a hydrogeological assessment to support the development of the Broadmeadow East (BME) Progressive Rehabilitation and Closure Plan (PRCP).

1.1 Background

BCC owns the BME open cut mine (Mine) located on mining lease (ML) 70257. The Project comprises an area of ~845 ha and is in the northern Bowen Basin, approximately 25 km northeast of Moranbah (Figure 1.1).

Operations at BME are conducted in accordance with Environmental Authority (EA) EA0002465, under the Queensland *Environmental Protection Act 1994* (the EP Act). EA0002465 includes conditions related to groundwater (D1 to 18) and was last amended in February 2023.

BCC is required to prepare a PRCP for submission to the Queensland Government. A PRCP is an element of the Queensland Government's Mined Land Rehabilitation Policy (State of Queensland 2021a) and the EP Act. The EP Act (State of Queensland 2022) requires that all areas disturbed within the relevant mining tenure are rehabilitated to a post-mining land use (PMLU), or managed as a non-use management area (NUMA).

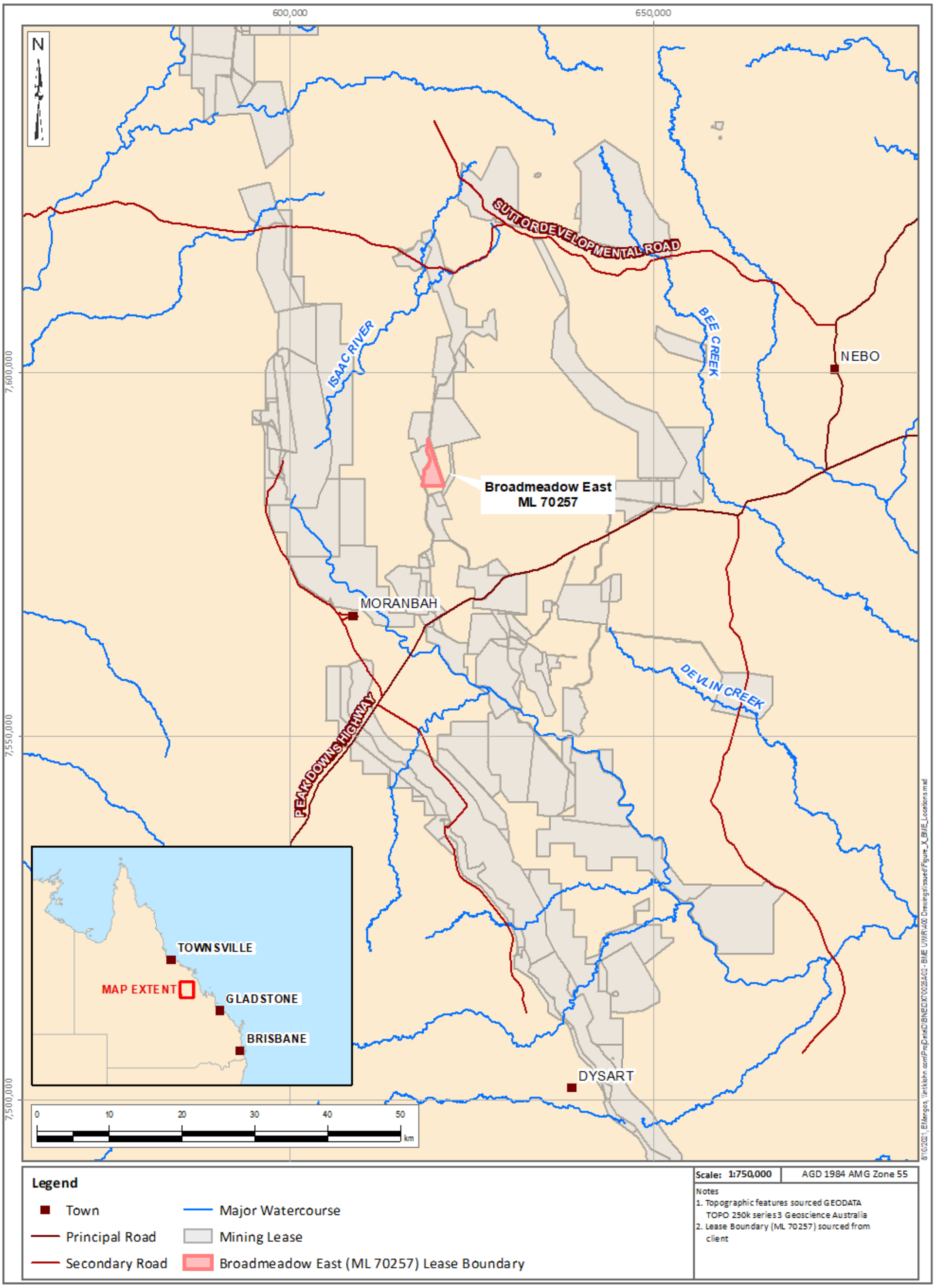


Figure 1.1 Location of BME

1.2 Scope of Work

A hydrogeological assessment is a requirement of the overarching PRCP. The Guideline: Progressive Rehabilitation and Closure Plans PRCP guideline (DES 2021) includes the following requirements for hydrogeology, and Table 1.1 indicates where in this report each requirement is addressed.

Table 1.1 PRCP Guideline Requirements for Hydrogeology

PRCP Guideline Requirements for Hydrogeology	Section Addressed in this Report
Determining the groundwater occurrence including the existence of, and depth to, aquifers and aquitards	Section 4.2
Locating groundwater recharge locations locally and regionally	Section 4.2
Groundwater quality within each of the aquifers and from surface expressions (i.e. seeps and springs)	Section 4.4 Section 4.5.2 Appendix III
Current and potential future uses of groundwater including existing groundwater extraction bores	Section 4.5.1
Groundwater flow direction and velocity, including field tests to determine hydraulic conductivity	Section 4.2
The development of potentiometric mapping and hydrostratigraphic cross sections	Section 4.2 Section 4.3
Groundwater modelling to inform an understanding of potential changes to groundwater level from dewatering or mine waste storage	Section 5.2 Appendix IV
Groundwater modelling to determine whether the void is acting as a sink or a source for groundwater	Section 5.2 Appendix IV
Cones of depression and associated impacts (as per Section 3.6.3 of PRCP Guideline)	Section 5.2 Section 6 Appendix IV

2 REGULATORY FRAMEWORK

This section describes the relevant regulations and requirements relevant to this hydrogeological assessment, prepared to support BME's PRCP.

2.1 Mineral Resources Act 1989

Underground and open cut mining activities are authorised under the *Mineral Resources Act 1989,* (State of Queensland 2021e). The *Mineral Resources Act 1989* is an Act to provide for the assessment, development and utilisation of mineral resources to the maximum extent practicable consistent with sound economic and land use management (State of Queensland 2021e).

2.2 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (State of Queensland 2022) is an Act with the objective of protecting Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).

This *Act* states that 'to carry out an environmentally relevant activity (ERA) an EA is required'. BME operate under the conditions EA0002465, authorised under the Queensland *Environmental Protection Act 1994* (EP Act) (State of Queensland 2021d).

Section 754 of the *Environmental Protection Act 1994* provides details related to requirements for mining EA holders to prepare a proposed PRCP.

2.3 Mineral and Energy Resources (Financial Provisioning) Act 2018

The *Mineral and Energy Resources (Financial Provisioning) Act 2018* (State of Queensland 2021c) was passed by Queensland Government in November 2018 as part of a broad package of reforms to improve rehabilitation and financial assurance outcomes in the resources sector. The Act was passed to replace the financial assurance arrangements for resource activities under the *Environmental Protection Act 1994.* Changes included a new financial provisioning scheme, changes to how the estimated rehabilitation cost for an EA is calculated and amendments to the *Environmental Protection Act 1994* to introduce new requirements for the progressive rehabilitation and closure of mined land.

2.4 Mined Land Rehabilitation Policy

The Queensland Government have established the Mined Land Rehabilitation Policy as they are committed to ensuring land disturbed by mining activities is rehabilitated to a safe and stable landform that does not cause environmental harm and is able to sustain an approved PMLU (State of Queensland 2021b).

A critical element of the Mined Land Rehabilitation Policy is the PRCP. The aim of the plan is to provide certainty about timing of rehabilitation. The plan will include binding, time-based milestones for actions that achieve progressive rehabilitation and will ultimately support the transition of the mine site's future use.

2.5 PRCP Guideline

DES published a PRCP guideline (ESR/2019/4964), the purpose of which is to assist applicants in developing a PRCP. The guideline was developed using contemporary best practice and industry standards, in line with the *Environmental Protection Act 1994* and the Mined Land Rehabilitation Policy (DES 2021).

The PRCP guideline has been used to assist with this hydrogeological assessment to support BME's PRCP.

2.6 Environmental Values

The Environmental Protection Act 1994 defines an Environmental Value (EV) as:

- A quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or
- Another quality of the environment identified and declared to be an EV under an Environmental Protection policy or regulation.

Under the *Environmental Protection Act 1994,* the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (State of Queensland 2019) is established as subordinate legislation to achieve the object of the Act in relation to Queensland waters.

The BME site is located in the Isaac River catchment. The *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* provides defined EVs and water quality objectives (WQOs) for the Isaac River catchment under Schedule 1 of the policy and are detailed in DEHP[1]. EVs for the Isaac River catchment are presented in Table 2.1 and include both the values for surface water and groundwater.

Table 2.1 Summary of Environmental Values

Water	Environmental Values											
	Aquatic Ecosystem	Irrigation	Farm Supply / Use	Stock Water	Aquaculture	Human Consumer	Primary Recreation	Secondary Recreation	Visual Recreation	Drinking Water	Industrial Use	Cultural And Spiritual
Isaac northern tributaries – developed areas	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Isaac groundwater	✓	✓	✓	✓			✓			✓		✓

✓ denotes the EV is selected for protection. Blank indicates that the EV is not chosen for protection.

The *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water) identifies environmental values for Queensland waters and wetlands to be enhanced or protected (aquatic ecosystems, water for drinking, water supply, water for agriculture, industry, and recreational use) and states water quality guidelines and WQOs for enhancing or protecting those environmental values.

[1] Note that the Queensland Department of Environment and Heritage Protection (DEHP) is now the Department of Environment and Science (DES)

The Isaac River Sub-basin Environmental Values and WQOs were established under a previous version of the EPP Water in September 2011. *It is noted that draft review consultation materials for the Fitzroy Basin were released for comment in 2017 but the review remains incomplete.*

More specifically, BME is located within the Isaac Northern Tributaries section of the Sub-basin, for which there are 'developed areas' values. For this overall region, Table 1 of the Isaac River Sub-basin Environmental Values and WQOs 2011 lists all Environmental Values - aquatic ecosystems, irrigation, farm supply/use, stock water, human consumer, primary and secondary recreation, visual recreation, drinking water, industrial use and cultural/spiritual values. BME's Receiving Environment Monitoring Program (REMP), as detailed in Condition C23 of the EA, is directed to addressing the parameters applicable to the area are for the protection of aquatic ecosystems.

The surface water resources, and the associated riparian habitat are described as *moderately disturbed*, owing primarily to the historical and ongoing grazing land use and the infrastructure overlays listed above.

2.6.1 Default Water Quality Guidelines and Water Quality Objectives

The WQOs for the Isaac Groundwaters (Zone 34) have been identified for both the shallow (Tertiary sediments) and deep systems (Permian units). The ANZG proposed default guideline values (DGVs) for indicators have been identified for aluminium, arsenic, molybdenum, and selenium. These are presented in Table 2.2.

Table 2.2 Default Guideline Values and WQOs for Key Analytes at BME

Indicator	Default Guidelines and WQOs						
	ANZG Default (mg/L) (Slightly to Mod. Disturbed - 80th Percentile)	Isaac Groundwaters (Zone 34) mg/L					
		Shallow (<30m)			Deep (>30m)		
		20th	50th	80th	20th	50th	80th
pH	-	7.10	7.75	8.10	7.40	7.80	8.03
Electrical conductivity (µS/cm)	-	498	2,150	8,910	3,419	6,100	16,000
Sulfate (mg/L)	-	12	140	318	25	138	398
Aluminium (mg/L)	0.055*	-	-	-	-	-	-
Arsenic (mg/L)	0.024*	-	-	-	-	-	-
Iron (mg/L)	-	0.000	0.030	0.140	0.000	0.050	0.246
Molybdenum (mg/L)	0.034^	-	-	-	-	-	-
Selenium (mg/L)	0.005#	-	-	-	-	-	-
TRH (C6-C9) (ug/L)	-	-	-	-	-	-	-
TRH (C6-C36) (ug/L)	-	-	-	-	-	-	-

*95% level of species protection recommended for slightly to moderately disturbed ecosystems
^ Unknown level of species protection
# To account for the bioaccumulating nature of this toxicant, it is recommended that the 99% species protection limit is used for slightly to moderately disturbed ecosystems.

3 OVERVIEW OF OPERATIONS

3.1 Current and Planned Operations

The Project is within the 947 ha, undeveloped ML70257 that was formerly a part of the Burton Coal Mine, located to the northeast of Moranbah in Central Queensland's Bowen Basin. CCO commercially acquired the Project from Peabody (Burton Coal) Pty Ltd in mid-2020 and ML ownership was officially transferred on January 27, 2021.

Clearing, topsoil removal, and establishment of the Mining Industrial Area (MIA) commenced in 2022.

The Project includes:

- Two Out of Pit dumps (OOPD), identified as West OOPD and East OOPD;
- North Pit;
- Central backfilled Pit;
- Southern Void;
- Water Management Infrastructures (i.e., sediment dams, MAW dam, North pit levee, groundwater monitoring bores);
- Mining Industrial Area (MIA); and
- Road, tracks and cleared areas.

Produced coal is processed offsite at a nearby wash plant. Existing rail infrastructure is used in transporting coal to port facilities.

The active Life of Mine (LOM) is an estimated five (5) years, during which an expected 8.3 million run of mine (ROM) tonnes will be extracted. The open pit and associated infrastructure are centrally located on the southern section of the Project area (Figure 3.1). Production is expected to continue until 2027, when closure and rehabilitation will start and continue for the subsequent five (5) years until 2032.

The Permian Rangal Coal Measures comprises the target coal seams for this Project, which include the Leichhardt, Vermont and Girrah Seams. These seams are separated by interbeds of carbonaceous mudstone, siltstone and sandstone. The Permian Rangal Coal Measures outcrop and sub-crop within the Project area and are overlain by the Rewan Group and underlain by the Fort Cooper Coal Measures.

Clearing and construction of the previously undeveloped mining area began in mid-2022. Vegetation was progressively cleared, grubbed, and stockpiled to preserve the topsoil and reduce erosion potential. The topsoil is stockpiled in two locations to avoid double handling and be easily accessible to the first areas of the developed area eligible for progressive rehabilitation. The first stockpile is adjacent to the northern portion of the pit and is no longer receiving topsoil. The second topsoil stockpile area is south of the West OOPDs and is where the remainder of reclaimed topsoil will be stockpiled until available for use in rehabilitation activities.

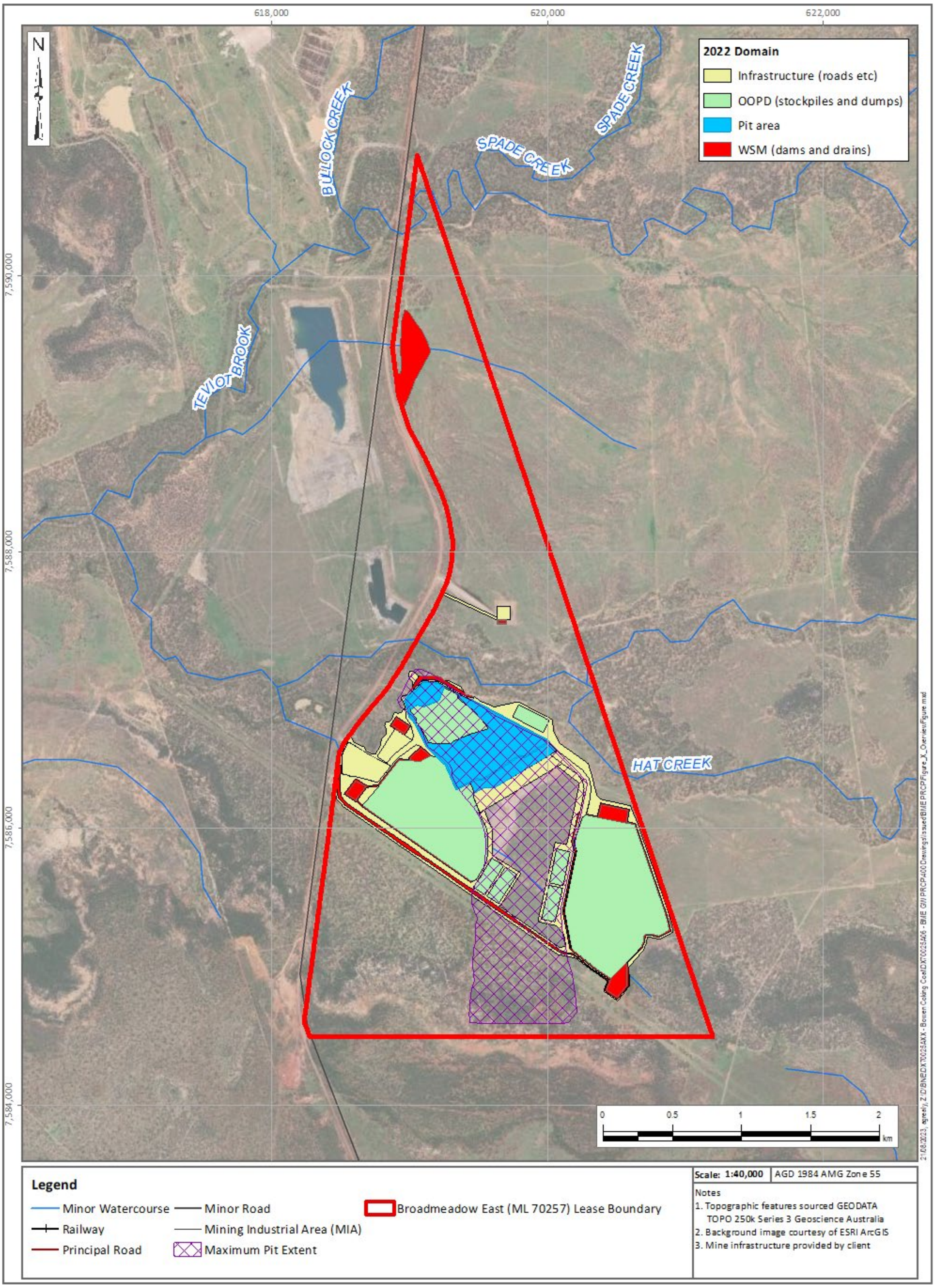


Figure 3.1 Project Overview

Mining commenced on the northern extent of the deposit in the last quarter of 2022 after sufficient overburden was removed. The initial overburden has been placed in the two OOPDs that will likely reach capacity during the first two years of operation. Overburden will also be placed within the pit as mining progressively moves south, resulting in a final void in the southern extent of the pit.

Mining will proceed in a southerly direction along the strike of the coal seams, with the pit excavated in a series of horizontal terraces, exposing the coal and waste on every bench.

At the cessation of mining, there will be one residual void in the southern end of the pit. The northern portion of the pit will be partially backfilled and kept available for use as bulk water storage during operation. This landform will be filled to the surrounding topography at the end of mine life when bulk water storage is no longer required. The southern void will be constructed as a water storage PMLU subject to the Residual Void (Southern void) Design and Closure Plan required by Condition G8 of the EA.

3.2 Closure Strategy

Following the cessation of mining operations at BME in 2028, the Project will enter a closure phase. Mining operations and the associated dewatering will cease, and the groundwater system will be allowed to recover. Rehabilitation strategies for the residual voids have been considered as part of the overarching PRCP scope (completed by others), and a final landform design has been prepared.

The final landform is shown on Figure 3.2, with the details are discussed in Table 3.1.

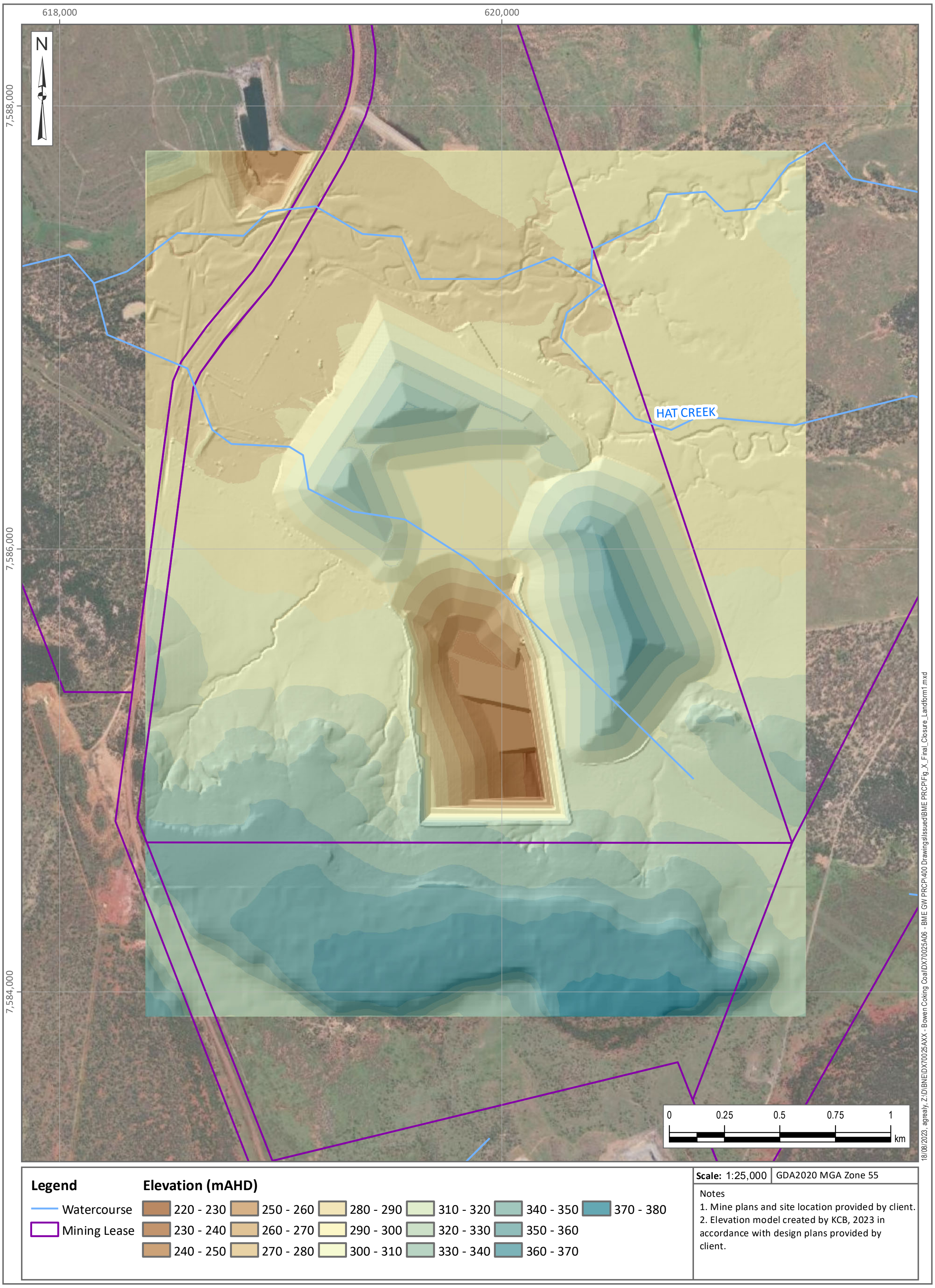


Figure 3.2 Proposed Final Landform

Table 3.1 Planned Closure Landform Details/Criteria*

Domain	Reshape Profile Parameters
North Pit	▪ Backfill level to natural ground level (water level based on groundwater conceptual modelling): 270mAHD. ▪ Slopes less than 15%.
Central backfilled pit	▪ Contoured to the surrounding topography as per landform design. ▪ Slopes less than 15%. ▪ 5 m capping of rejects within central backfilled pit with overburden that is non-reactive (geochemically and physically inert).
Southern Void	▪ Install slopes and batters as per the void closure plan. ▪ Overall slope: 15%. ♦ Final pit walls (Competent material): 70 degrees. ♦ Final pit walls (Incompetent material): 45 degrees. ♦ Underwater slopes: Angle of repose ~37 degrees. ▪ Void maximum surface area (31 ha). ▪ Void maximum depth (105 m). ▪ Maximum void lake equilibrium level will not reach 300 mAHD. ▪ Surface drainage direction: into the void. ▪ Backfill above the groundwater level (water level based on conceptual modelling). ▪ Safety bund constructed at 2 m high, base width of 5 m from unweathered, freely draining, end-dumped rockfill at a minimum 20 m offset from the pit perimeter as per the closure plan.
Out of Pit Dumps (OOPD)	Outer slopes: ▪ 15% as per landform design, and drainage outward away from OOPD towards original topo drainage paths. Inner slopes (into full backfill area). ▪ 12% as per landform design, and drainage outward away from void towards original topo drainage paths.

**Taken from Table 2 in EA0002465*

3.3 Surrounding Mines

There are several mining leases surrounding the Project. These are shown on Figure 3.3, and include:

- South of the Project is Broadmeadow Central (ML70338), with the Broadlea North Mine (ML 70345) located 3 km further south.
- Immediately west is the former Broadmeadow West (ML 70256) held by Peabody.
- North of the Project area are other Mining leases of the Burton Mine held by Peabody (ML 70258, ML 70259, ML 70252) and Ironbark No.1 (ML 700024) held by Fitzroy. (CQ) Pty Ltd.
- Arrow Energy and Blue Energy operate several of the CSG gas fields located within a 10 km radius of the Project area.

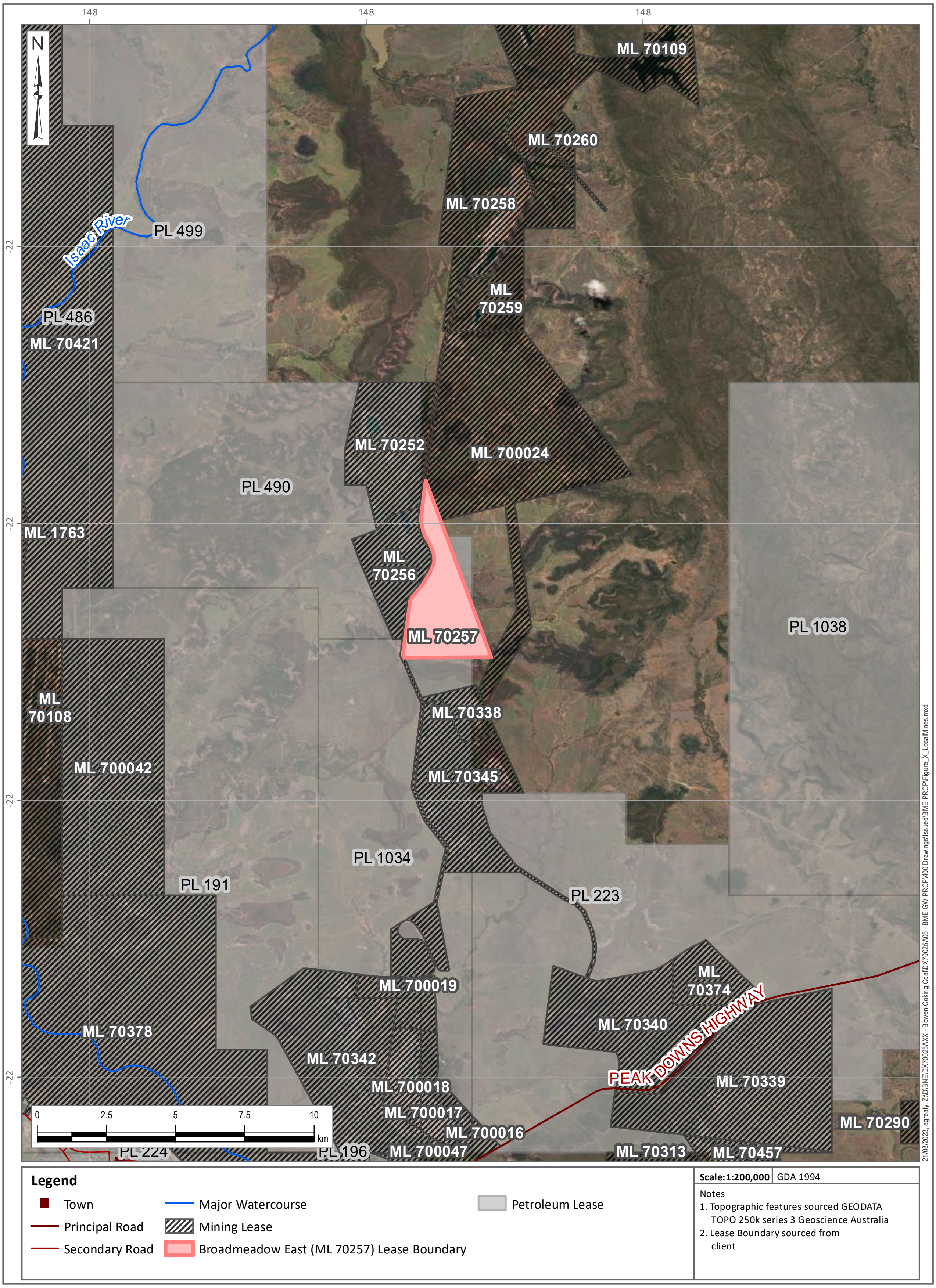


Figure 3.3 Surrounding Mining Projects

3.4 Groundwater Monitoring Network

The current groundwater monitoring network at BME includes 11 monitoring bores, which are screened at varying depths in five hydrostratigraphic units. The current bore network are listed in the BME EA and were selected to monitor potential changes in groundwater conditions due to the mining activities in BME (KCB 2021a).

The groundwater monitoring network at and surrounding BME and are presented in Table 3.2 and shown in Figure 3.4.

Table 3.2 Groundwater Monitoring Network

Bore ID	Location (AMG84, Zone 55)		Surface Elevation (mAHD)	Depth (m)	Screened unit	Current Status (August 2023)
	Easting (m)	Northing (m)				
BME Monitoring Bores						
MBBE0008	620181	7584916	305	135	Rangal Coal Measures	Ongoing monitoring
BDW172(54)	619333	7586689	289	54	Rangal Coal Measures	Mined out as of Q2 2022
BDW8C	619762	7585670	302	99	Rangal Coal Measures	Ongoing monitoring. To be replaced in Q3/4 2023
BDW5C	619731	7586791	292	79	Rangal Coal Measures	Mined out as of Q3 2022. To be replaced in Q3/4 2023
BDW172(32)	619333	7586689	289	32	Rewan Group	Mined out as of Q2 2022. To be replaced in Q3/4 2023
MBBE0002b	618324	7585162	323	60	Tertiary Sediments	Ongoing monitoring
MBBE0003	618281	7584512	346	20	Basalt	Ongoing monitoring
MBBE0004	620081	7586800	290	6	Alluvium	Ongoing monitoring
MBBE0006	619056	7587072	284	6	Alluvium	Ongoing monitoring
BME Compliance Bores						
MBBE0001	619739	7585223	305	67	Rangal Coal Measures	Ongoing monitoring, to be replaced in Q3/4 2023
MBBE0007	620535	7586212	297	52	Rewan Group	Ongoing monitoring
Regional Monitoring Network						
BDW366P	619163	7587709	290	94	Rangal Coal Measures	Not monitored
BDW367P	618778	7589869	289	186	Rangal Coal Measures	Not monitored
BDW368P	618014	7591478	295	131	Rangal Coal Measures	Not monitored
BDW46	617649	7593762	338	251	Rangal Coal Measures	Not monitored
PT1	620938	7595822	329	138	Rangal Coal Measures	Not monitored
BDW148	618641	7587996	289	54	Rewan Group	Not monitored
EFGW2D	623609	7591549	308	25	Rewan Group	Not monitored
EFGW3D	622271	7593815	306	30	Rewan Group	Not monitored
EFGW4D	619888	7593747	300	40	Rewan Group	Not monitored
EFGW5D	620848	7595275	320	59	Rewan Group	Not monitored
EFGW1S	619392	7590558	283	11	Alluvium	Not monitored

Monitoring data from these bores were used to refine model calibration and to supplement groundwater level and quality data to conceptualise the hydrogeological environment surrounding the mine. These surrounding bores are shown in Figure 3.4.

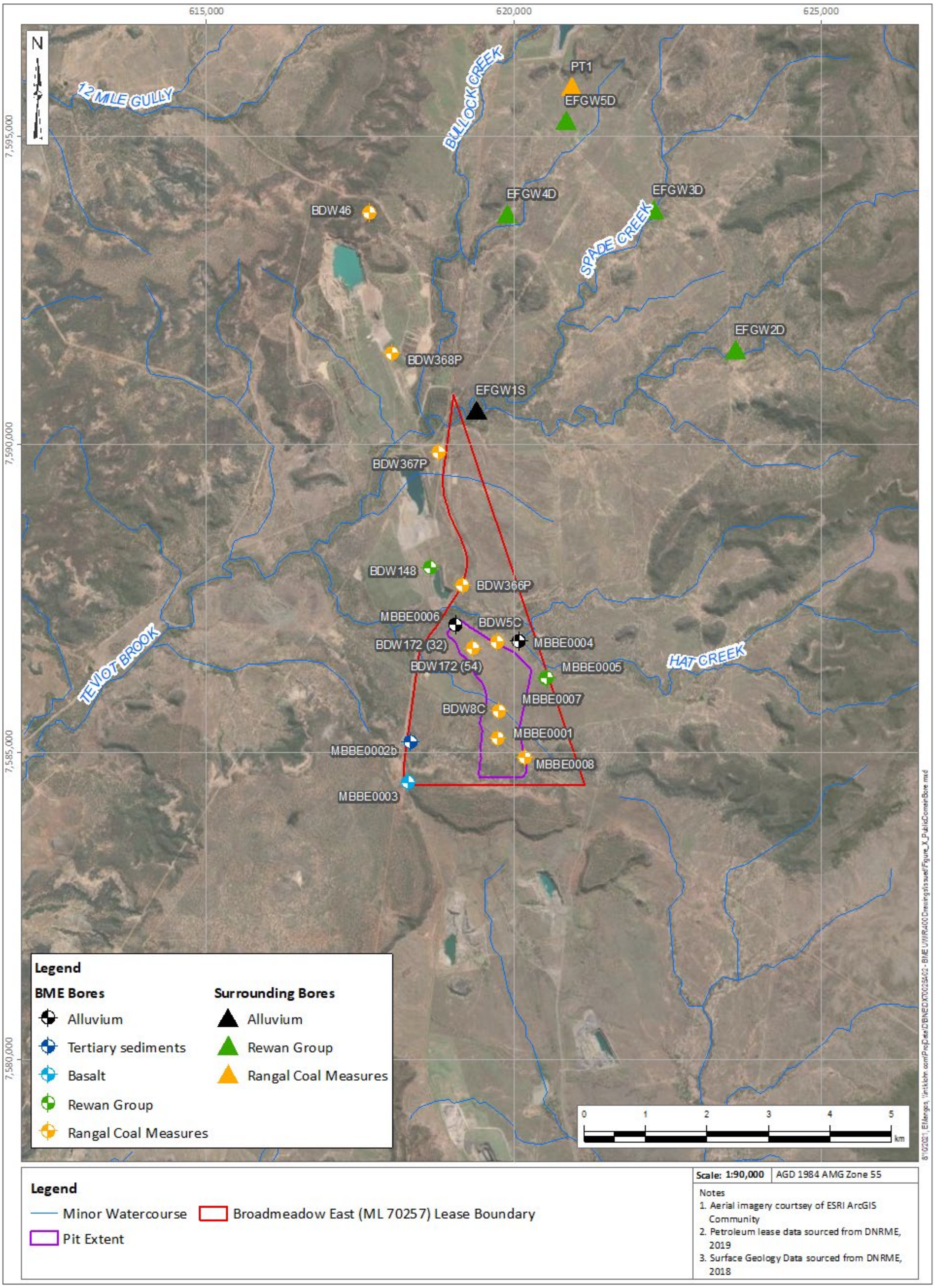


Figure 3.4 BME Monitoring and Regional Monitoring Bores

4 HYDROGEOLOGICAL CONCEPTUAL MODEL

4.1 Physical Setting

4.1.1 Climate

The climate of the Project area is classified as sub-tropical continental, characterised by high variability in rainfall, temperature and evaporation, typical of the Central Queensland region, based on the modified Köppen classification system (BOM 2005).

Long-term rainfall data[2] was sourced from the Scientific Information for Landowners database (SILO) at Latitude -21.80, Longitude 148.15, located within the Project area. Summary statistics for rainfall, temperature, and evaporation are presented in Table 4.1 (DES 2023).

Mean maximum temperatures range between 33°C in the summer months and 23°C in the winter months. Mean minimum temperatures range between 21°C in the summer months and 9°C in the winter months. Daily evaporation rates are generally high and exceed rainfall throughout the year. The highest rainfall occurs during December to February, with the lowest rainfall occurring during April to October.

Table 4.1 Climate Statistics

Site	SILO Point Longitude 148.15, Latitude -21.80			
Statistic Element	Mean Max. Temperature (°C)	Mean Min. Temperature (°C)	Mean Monthly Evaporation (mm)*	Mean Monthly Rainfall (mm)
Period of record	**1970 to 2023**	**1970 to 2023**	**1970 to 2023**	**1970 to 2023**
January	32.8	21.5	213.8	105.8
February	32.1	21.3	173.1	98.7
March	31.1	19.9	177.0	67.2
April	28.7	17.0	141.9	34.5
May	25.7	13.5	115.5	33.4
June	23.1	10.0	92.8	21.9
July	23.0	8.8	103.2	22.1
August	25.0	10.0	133.4	21.3
September	28.2	13.2	172.8	10.6
October	31.0	16.7	214.5	30.3
November	32.4	19.1	223.5	63.6
December	33.2	20.8	229.1	96.4
Annual	**28.9**	**16.0**	**165.9**	**50.5**

The rainfall data was analysed to produce a cumulative rainfall departure (CRD) trend (Figure 4.1). CRD trends present a running deviation of long-term actual rainfall against the average. This provides seasonal-scale identification of trends (wet/dry) and longer term (e.g., decadal) deviation from average conditions. These trends result in a natural tempering of peaks for rainfall events, and therefore support the correlation of rainfall events to aquifer responses.

The CRD highlights the cyclic wet-dry seasonal climate of the site. An overall declining trend, with below average rainfall occurred from 2013 to 2021. The CRD indicates a slightly increasing trend from 2021 to present, signifying above average rainfall conditions.

[2] Rainfall data from 1 Jan 1970 to 24 April 2023

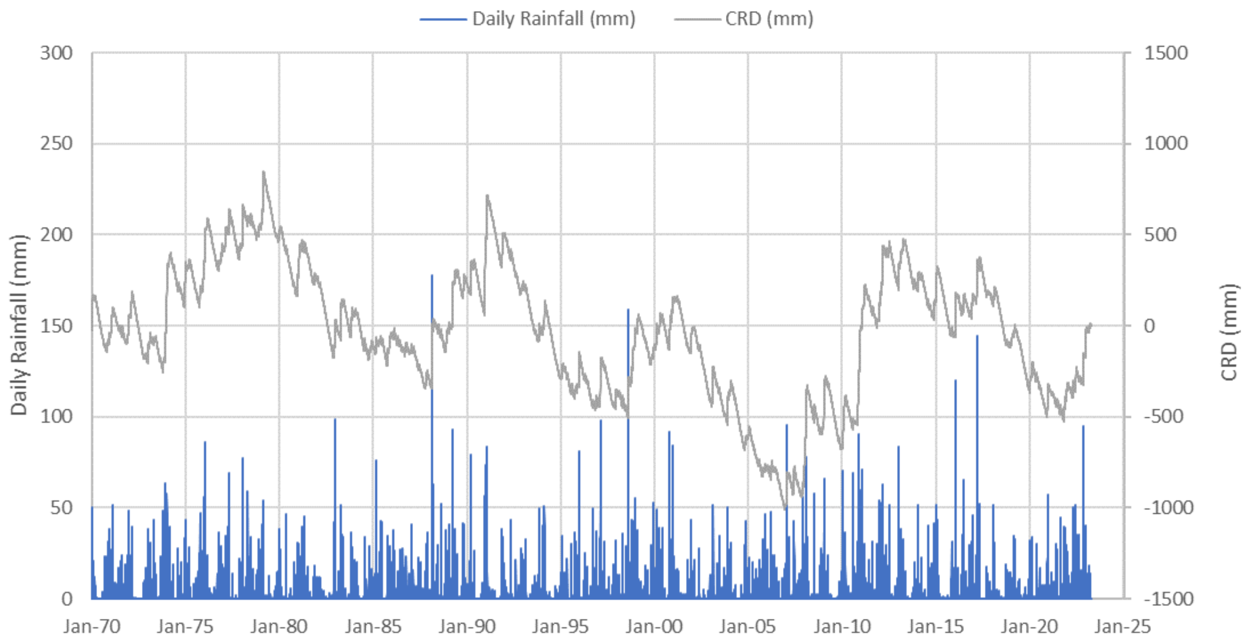


Figure 4.1 Daily Rainfall and Cumulative Rainfall Departure Trend

4.1.2 Topography and Drainage

The Project is located in the Isaac River catchment, a sub-basin of the upper Fitzroy Basin. The Isaac River catchment covers an area of approximately 22,000 km^2 and discharges to the Connors River approximately 140 km to the southeast of the Project area, and subsequently into the Fitzroy River a further 180 km southeast. The Isaac River is located approximately 12 km to the west of the Project and flows in a north to south direction.

The Project is located within the Teviot Brook catchment, a sub-catchment of the Isaac River with an area of approximately 260 km^2. Watercourses within the Teviot Brook catchment are ephemeral with highly variable flows, characterised by short duration flows associated with episodic storm events during the wet season. Hat Creek, a tributary of Teviot Brook, flows from east to west and comprises numerous minor tributaries that transect the Project.

Topography across the Project area range between ~275 mAHD towards the northwest and ~380 mAHD in the southeast, as presented in Figure 4.2. To the south of the Project area is a residual Tertiary laterite hill rising approximately 40 m above the general land surface.

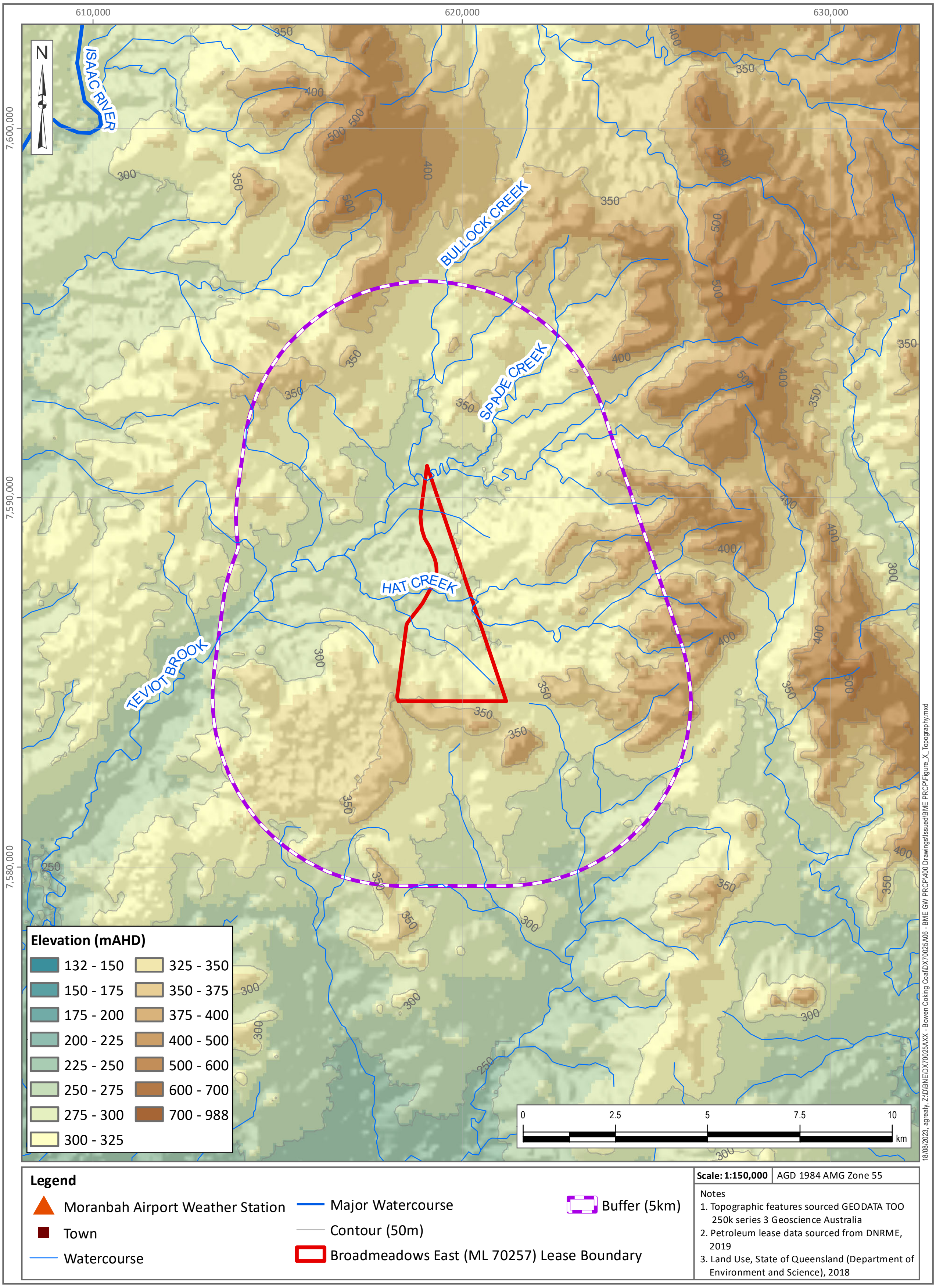


Figure 4.2 Topography and Drainage of the Project Area

4.1.3 Regional Geology

The Bowen Basin is the northernmost part of the 1,800 km long Bowen-Gunnedah-Sydney Basin in eastern Queensland and New South Wales. The Project is in the western part of the central Bowen Basin. The basin comprises an accumulation of Permian and Triassic sediments. The economic coal seams in the Bowen Basin lie within the Permian Blackwater and Back Creek Groups. The Moranbah coal measures are within the Back Creek Group, while the Fort Cooper and Rangal Coal Measures exist within the Blackwater Group. All are late Permian coal bearing sequences which were deposited in terrestrial (Blackwater Group) and marine environments (Back Creek Group). This Permian coal strata are overlain by the Triassic Rewan and Clematis Groups. The economic coal seam deposits specific to the Project target area occur within the Rangal Coal Measures.

The surface geology and bedrock geology within the vicinity of the Project area are provided in Figure 4.3 and Figure 4.4; while a summary of the stratigraphy is provided in Table 4.2.

Quaternary alluvium is present across the entire Hat Creek extent within the Project area. The alluvium comprises sands, silts and clays associated with stream channels and flood deposits and ranges in thickness from 3 m to 4 m in the Project area.

Tertiary sediments are also present to the south of Hat Creek and typically consists of semi-consolidated quartz sandstone, clayey sandstone, mudstone and conglomerate and fluvial lacustrine sediments. The Suttor Formation, mapped as *Tu*, has been extensively weathered and reworked during the Tertiary and Quaternary, resulting in an upper profile that includes Tertiary and Quaternary colluvial sheetwash deposits and residual soils (regolith) that comprise clay, silt, sand, gravel and soil.

Tertiary basalt has been mapped to the south of the Project area and comprises a heterogeneous profile of vesicular and massive basaltic lavas with minor tuff and ash. While not confirmed within the Project area to date, previous investigations at surrounding sites have indicated that a Tertiary sand is often present beneath the basalt paleochannel (KCB 2020a). Where present, this unit is often referred to as basal sand.

There are two Triassic units identified within the vicinity of the Project area: the Clematis Group, and the Rewan Group. Outcrop of the Clematis Group is observed to the northeast of the Project area is not encountered within the Project area. The Rewan Group is present across the Project area and represents a prominent lithological unit that separates the underlying Permian coal measures from the overlying shallow Cenozoic stratigraphy.

The Permian Rangal Coal Measures (RCM) is the primary coal bearing unit at BME. This unit outcrops and sub-crops within the Project area and is overlain by the Rewan Group and underlain by the Fort Cooper Coal Measures. Target coal seams in the RCM include the Leichhardt, Vermont and Girrah Seams, which are separated by interbeds of carbonaceous mudstone, siltstone and sandstone.

Table 4.2 Summary of Stratigraphy in BME

<table>
<tr><th>Age</th><th>Group</th><th>Unit</th><th>Lithology</th></tr>
<tr><td>Quaternary</td><td>-</td><td>Recent alluvium</td><td>Soil, clay, silt, sand, gravel.</td></tr>
<tr><td rowspan="2">Tertiary</td><td>-</td><td>Sediments (Suttor Formation and Duaringa Formation)</td><td>Sandstone, mudstone, conglomerate, siltstone.</td></tr>
<tr><td>-</td><td>Basalt</td><td>Olivine basalt of Clermont Springsure basalt Province.</td></tr>
<tr><td rowspan="2">Triassic</td><td colspan="2">Clematis Group</td><td>Sandstone, siltstone, mudstone and granule to pebble conglomerate.</td></tr>
<tr><td colspan="2">Rewan Group</td><td>Red and green mudstone, green lithic sandstone, occasional pebble conglomerate.</td></tr>
<tr><td rowspan="2">Upper Permian</td><td rowspan="2">Blackwater Group</td><td>Rangal Coal Measures</td><td>Carbonaceous mudstone, siltstone, sandstone. Coal seams:
▪ Burton Seam (splitting to the Leichhardt and Vermont Seam).
▪ Girrah Seam.</td></tr>
<tr><td>Fort Cooper Coal Measures</td><td>Coal seams, carbonaceous shale, mudstone, sandstone, siltstone, conglomerate.</td></tr>
</table>

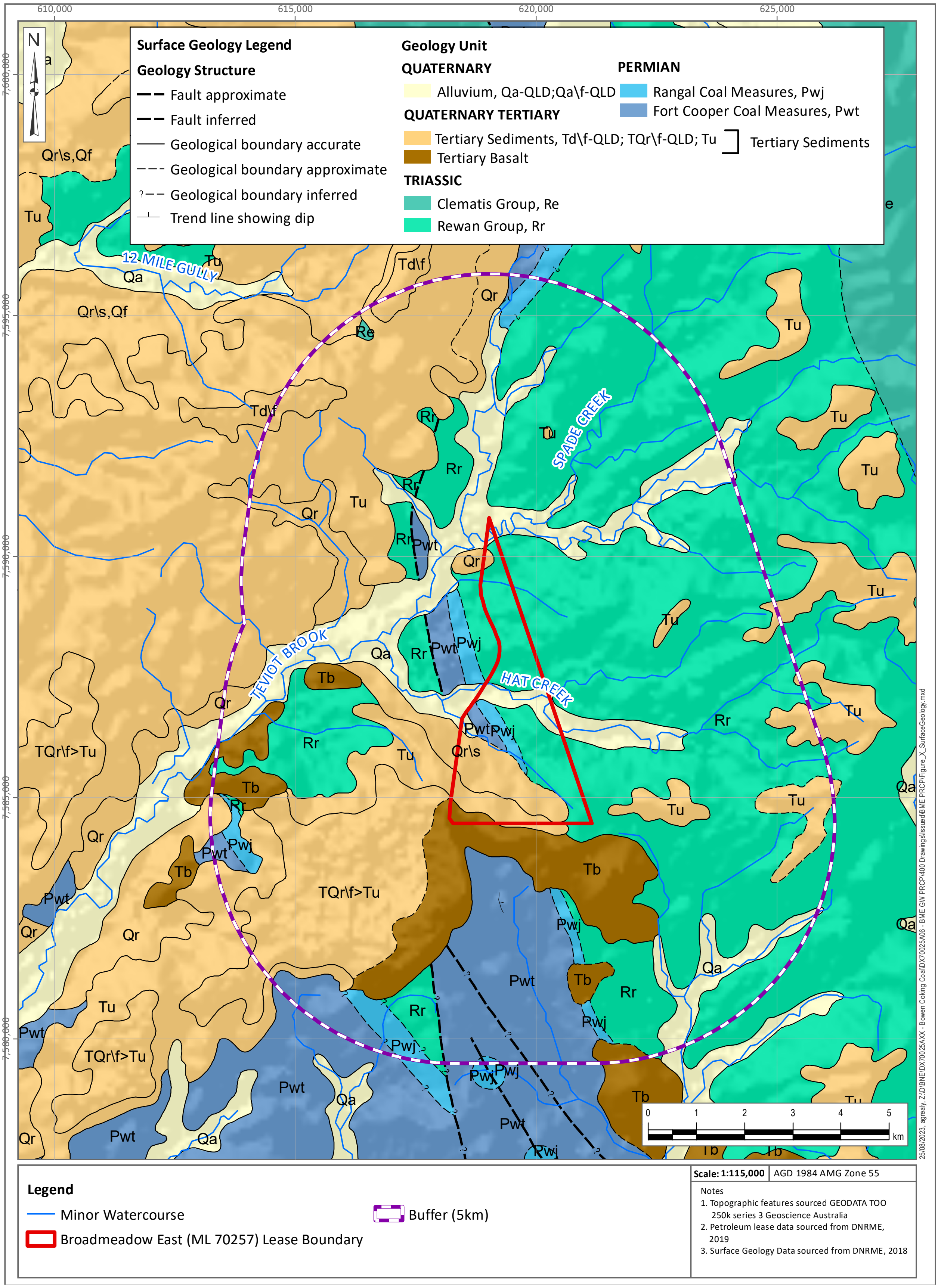


Figure 4.3 Mapped Surface Geology

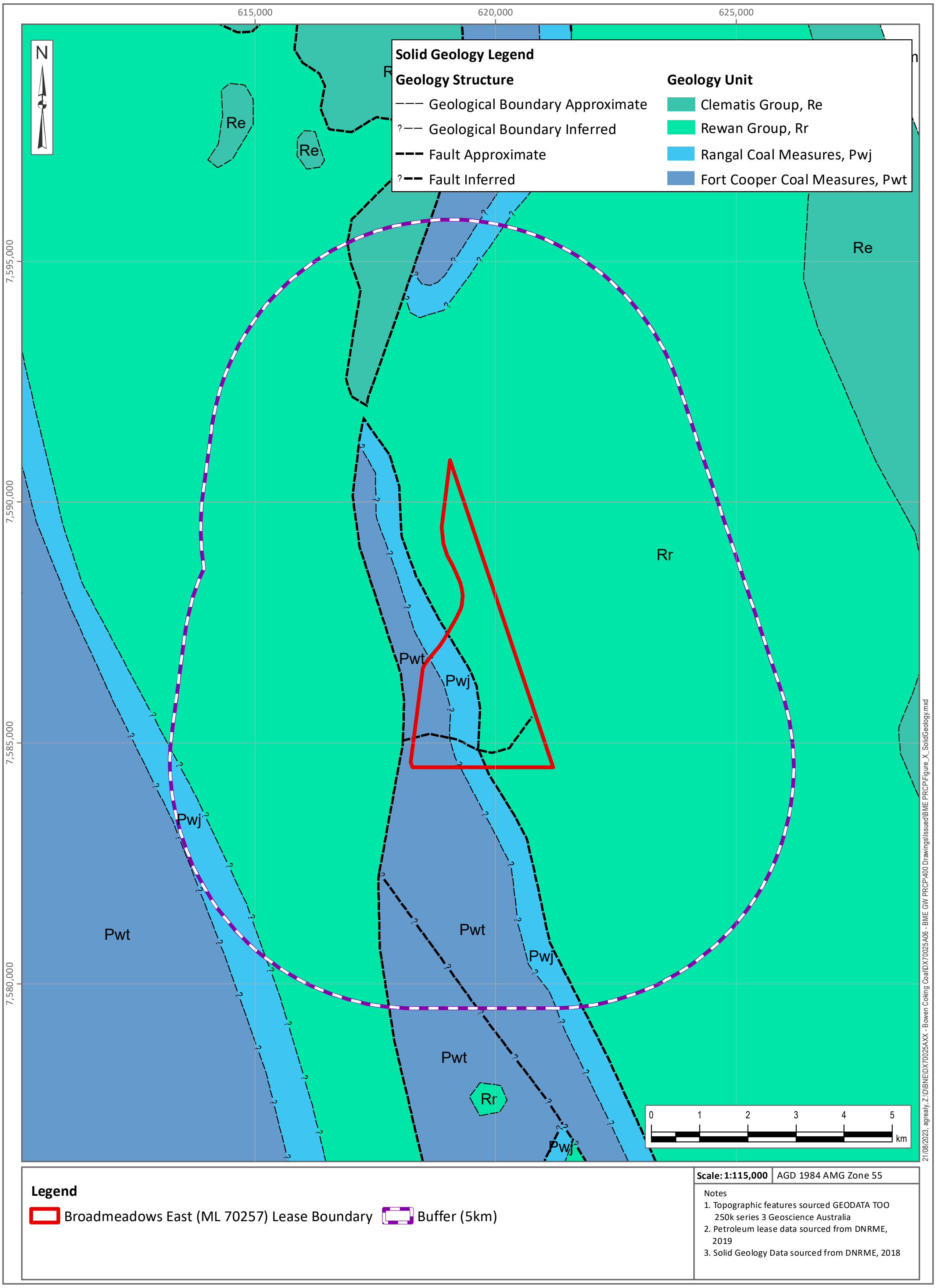


Figure 4.4 Mapped Bedrock Geology

4.2 Hydrostratigraphic Units

The hydrostratigraphic units of relevance are based on the geological units summarised in Table 4.2 and presented in Figure 4.5. Details for each of the hydrostratigraphic units are provided in the following sections.

4.2.1 Quaternary Alluvium

Spade Creek and Hat Creek, tributaries of Teviot Brook and ultimately the Isaac River, flow through the north and central portions of the Project area, respectively. Within the vicinity of the Project area, the distribution of alluvium is limited to these ephemeral watercourses and their associated floodplains.

Previous hydrogeological investigations (KCB 2018) were undertaken downstream and to the west of the Project area and showed that the regional groundwater table is typically located several metres below the base of the alluvium (associated with Teviot Brook). This signifies that the alluvium is perched above the regional groundwater system, typically dry and unsaturated. Drilling and bore installations completed as part of field investigations confirmed that the alluvium associated with Hat Creek and Spade Creek are also typically dry (KCB 2021b). Drilling results within the Project area show that the thickness of the alluvium ranges from 3 m to 4 m (KCB 2021a).

Based on referenced investigations completed in the vicinity of the Project area (KCB 2018) the hydraulic conductivity of the alluvium is highly variable and is a function of the relative proportions of sand and fine clay and silt. Typically, the unconsolidated sediments of the smaller tributaries of the surface water catchment (e.g., Hat Creek, Spade Creek) comprise bed sands within the watercourse channel. This differs from larger watercourses (e.g., Isaac River) where alluvial terraces have formed on floodplains adjacent to the main watercourse channel. The alluvium associated with the bed sand have a higher hydraulic conductivity than the floodplain alluvium, however, these bed sands are localised to the smaller creek channels. The hydraulic conductivity of the bed sand ranges from 8.9 m/d to 45 m/d (KCB 2018).

Mechanisms for groundwater recharge to the alluvium include:

- Direct rainfall infiltration to the alluvium; and
- Seepage of surface water into the creek bed during seasonal flow events in the creek. Based on stream gauging from surrounding projects the surface water flow in the creek is anticipated to be limited to short duration events during and immediately following sustained seasonal rainfall. These flow events result in discrete, short duration recharge events through the alluvium that will dissipate to the surrounding groundwater regime and/or flow downstream within the alluvium.

Regionally, the piezometric surface and groundwater flows within the alluvium is a compartmentalised reflection of surface topography when groundwater is present within this unit. Within the Project area, groundwater flow in the alluvium is from east to west and follows the gradient and alignment of Hat Creek.

There are currently two monitoring bores in the Hat Creek alluvium; MBBE0004 located upstream of the Project, and MBBE0006 located downstream of the Project. The monitoring records for MBBE0004 and MBBE0006 confirm that the alluvium is predominantly dry (KCB 2022).

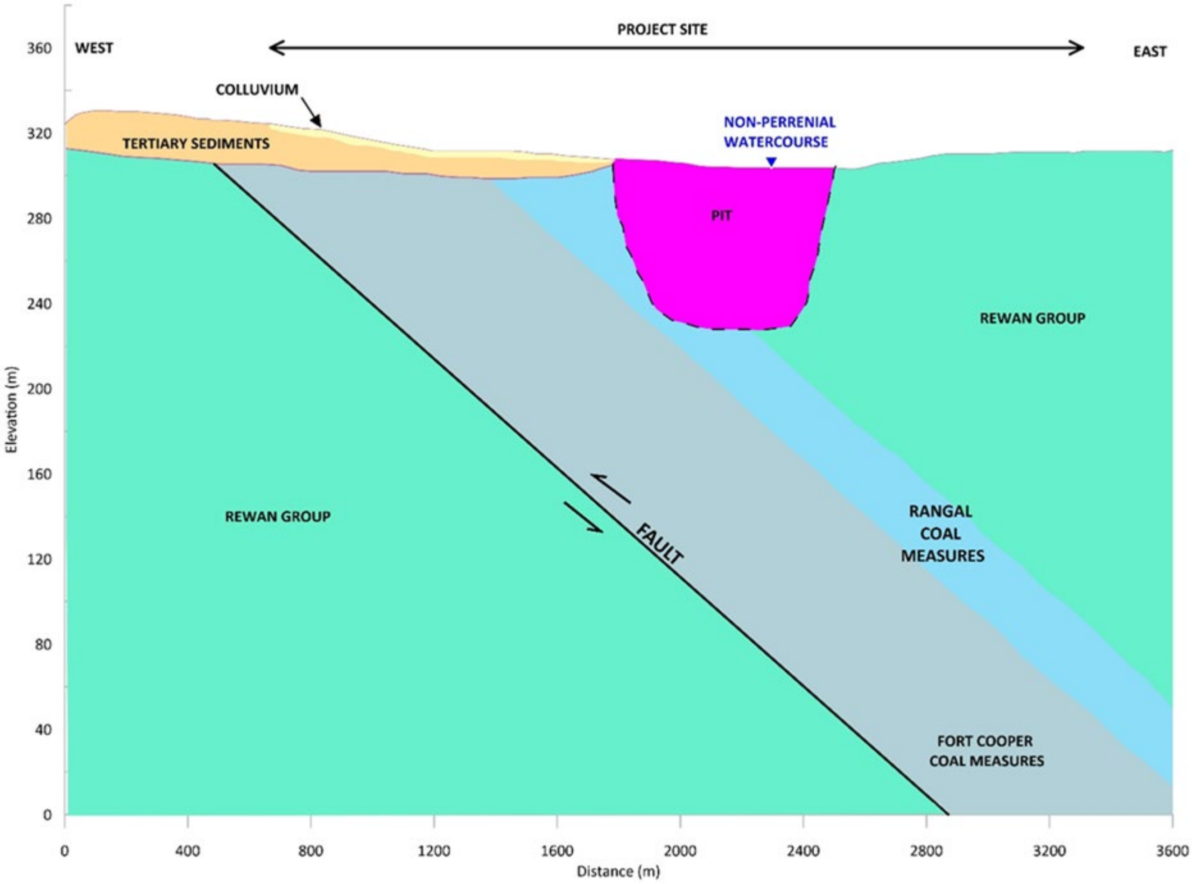


Figure 4.5 Cross-section of Project area

4.2.2 Tertiary Sediments

The Tertiary sediments comprises a heterogeneous profile of semi-consolidated quartz sandstone, clayey sandstone, mudstone and conglomerate, fluvial lacustrine sediments, and minor interbedded basalt. These sediments form a thin veneer of up to 15 m in thickness and are predominantly located to the south of the Project area, and sporadically within a 5 km buffer.

The Tertiary sediments do not store significant groundwater and are not considered a significant aquifer. As with the alluvium, these units are typically located above the regional groundwater table and are therefore generally dry. As a result, site specific testing of the hydraulic conductivity for this unit was unable to be undertaken. However, hydraulic testing has been completed on the Tertiary sediments unit at surrounding projects (KCB 2018). Results from the test work completed on surrounding projects indicate that the hydraulic conductivity for the Tertiary sediments ranges from 7×10^{-4} m/d to 1.22 m/d. In the vicinity of the Project area, groundwater in the Tertiary sediments is observed to the west of the proposed pit area.

Recharge to the Tertiary sediments is interpreted to occur as a result of direct rainfall infiltration, where the sediments outcrop at surface, and where present, downwards leakage from the overlying alluvium.

Groundwater level records from MBBE0002 indicate limited change in the water level during the monitoring period, which is a reflection of limited recharge to the Tertiary sediments.

4.2.3 Tertiary Basalt

The Tertiary basalt underlies the Tertiary sediments and overlies the Rewan Group, typically occurring as a single composite unit comprising massive and vesicular lava, tuff, and ash flows. The upper basalt profile mapped to the south of the Project area is highly weathered and comprises a basaltic clay.

Tertiary basalt is mapped to the south of the Project area and is present in the southwest of the lease. Monitoring bore MBBE0003 is the only bore within the Project area installed in the Tertiary basalt. No basalt was encountered in any other bore in the Project area; therefore, the southern edge of the Project area corresponds with the northern extent of the basalt. The presence of this basalt corresponds with a topographic high and is limited in its extent, likely to be a basalt plug or minor flow. The basalt on the mining lease represents a thin veneer of basalt, which typically comprise weathered and/or massive basalt that has very low hydraulic conductivity, as opposed to the basalt further south in the centre of the unit which is likely to have more typically compartmentalised zones of high hydraulic conductivity with the presence of groundwater. The basalt encountered in MBBE0003 was 15 m thick and dry (KCB 2021b). Limited occurrence of groundwater is observed in the vicinity of the mining area, as observed through basalt monitoring bore MBBE0003 (KCB 2022).

The hydraulic properties of the basalt can vary considerably as groundwater is primarily stored within highly compartmentalised fractures and vesicular zones (KCB 2018).

The Tertiary basalt is a key water bearing unit in the Bowen Basin. However, within the vicinity of the Project area there is limited occurrence of this unit. Tertiary basalt is present in the southern extent of the Project area, is relatively thin (~7 m), highly weathered and unsaturated. As a result, it was not possible to conduct hydraulic testing of the encountered basalt. Hydrogeological investigations completed at surrounding projects included hydraulic testing of the weathered Tertiary basalt (KCB 2018; 2020b). Results of these tests estimate the range of hydraulic conductivity to be 0.002 m/d to 2.6 m/d.

4.2.4 Triassic Rewan Group

The Rewan Group is a thin interbedded sequence of siltstone, claystone and minor fine-grained sandstone that overlies the Permian coal measures. This unit outcrops across majority of the eastern portion of the Project area and sub-crops beneath the alluvium, Tertiary sediments and basalt where present. The Rewan Group is uniformly saturated at depth and may become unsaturated where it outcrops or sub-crops above the regional groundwater table.

The Rewan Group is recognised as a regional aquitard and acts as a confining unit overlying the Permian sediments.

The measured hydraulic conductivity of the Rewan Group within the Project area is 2.4 m/d (KCB 2021b). In comparison, the tested Rewan Group units at surrounding projects indicate a hydraulic conductivity range from 1 x 10^{-3} m/d to 6.5 m/d (KCB 2018; 2020b). In general, the Rewan Group is recognised as a regional aquitard and acts as a confining unit overlying the Permian coal measures; and is typically characterised by low primary porosity.

The groundwater level records from most of these bores indicate limited variability in levels over the duration of the monitoring period (Jan 2000 to March 2023), with limited variability as a result of seasonal changes, indicating limited connectivity with overlying strata or the surface water system.

4.2.5 Permian Coal Measures

The Permian coal measures include the Rangal Coal Measures and the Fort Cooper Coal Measures. These comprise alternating layers of fine to medium grained sandstone, siltstone and coal, including the target Leichhardt and Upper Vermont seams of the Rangal Coal Measures. Permian strata occur across the Project area as a regular layered sedimentary sequence dipping to the east, with outcrops of these units observed within the Project area and sub-cropping beneath the Rewan Group towards the east. The Permian strata also sub-crop beneath the alluvium, Tertiary sediments and basalt within the vicinity of the Project area.

Individual coal seams form the principal water bearing strata within the coal measures and are therefore typically saturated throughout their full thickness; but may become unsaturated where they outcrop or sub-crop above the regional groundwater table. Groundwater storage and movement occurs within the coal seam cleats and fissures and within open fractures that intersect the seams. Data shows limited changes in water levels in the coal measures due to seasonal climatic variability, indicating limited connectivity with overlying strata the surface water system.

Hydraulic tests estimated the hydraulic conductivity of the Leichhardt seam to be ranging from 0.19 m/d to 0.36 m/d (KCB 2021b). These values correlate with other hydraulic tests completed on the Leichhardt seam at surrounding projects (KCB 2020b), with an estimated hydraulic conductivity ranging from 0.07 m/d to 2.3 m/d. Hydraulic testing have also been completed on the Rangal Coal Measures overburden/interburden between the coal, which have resulted in an estimated hydraulic conductivity of 1 x 10^{-5} m/d to 2 m/d.

4.2.6 Structural Features

Geological mapping completed in the vicinity of the Project area have identified a north-south striking regional fault structure located to the west of the Project area. Movement along this fault plane has caused the uplift and associated erosion of the Permian coal measures to the east of the fault, resulting in the outcrop and sub-crop of the Permian strata. Similar north-south striking regional faults are present across the Bowen Basin, which display hydraulic characteristics that restrict groundwater flow in the horizontal direction.

4.3 Groundwater Levels and Flow

A summary of the groundwater levels and flow conditions for each of the relevant hydrostratigraphic units across the Project area is provided in the following sections. The depth to groundwater level across the Project site is provided in Figure 4.6. Hydrographs are presented in Figure 4.7 to Figure 4.10.

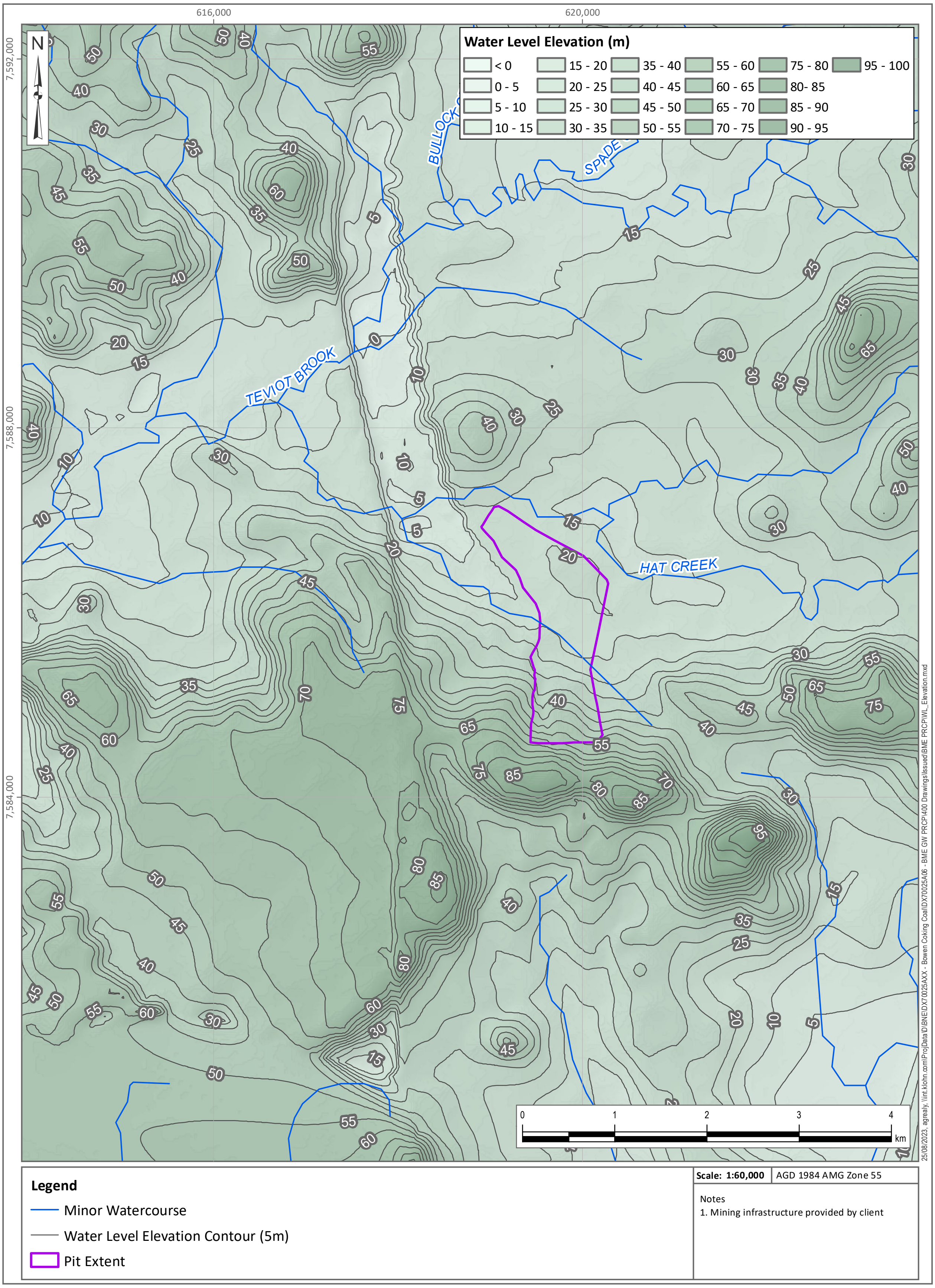


Figure 4.6 Depth to Groundwater Level at the End 2021

4.3.1 Quaternary Alluvium

Bore EFGW1S has been monitored for groundwater levels historically and installed adjacent to Teviot Brook, screening the alluvium, to the north of the Project area. Groundwater levels in this bore (Figure 4.7), over the period of monitoring, fluctuate by up to 3 m, with higher water levels observed during the wet season and lower water levels observed during the dry season. Groundwater levels show a good correlation to the CRD trend, which is also presented on the hydrograph.

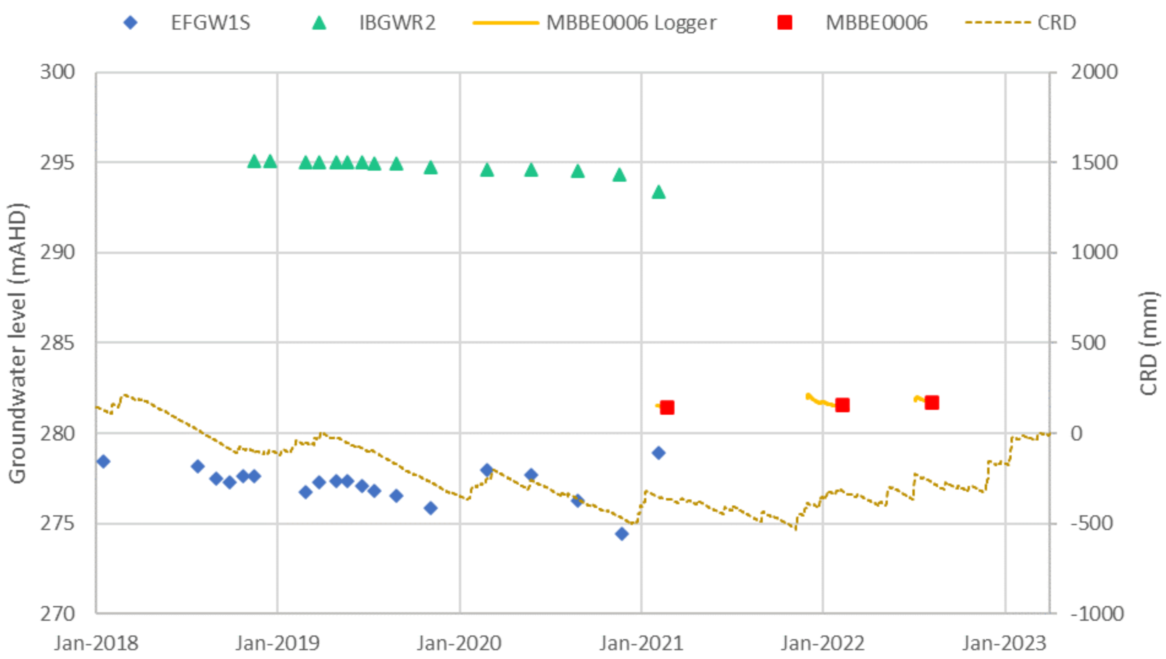


Figure 4.7 Groundwater Elevation Hydrograph – Bores Screened in the Alluvium

Groundwater levels in IBGWR2 have remained relatively stable with limited change during monitoring from 2018 to 2023. In comparison to Hat Creek, the watercourse adjacent to the north of the proposed pit, Teviot Brook is a larger watercourse with a larger accumulation of alluvium and a higher potential for groundwater storage. Between 2018 and 2021 some groundwater levels were measured at EFGW1S and IBGWR2 and these varied between 2 mbGL[3] and 7 mbGL.

Two monitoring bores have been installed in the alluvium associated with Hat Creek (MBBE0004 and MBBE0006) within the Project area. Since installation (January 2021) no groundwater has been observed within these bores. Figure 4.7 indicates that the alluvium becomes saturated following rainfall events, due to the contribution of surface water recharge into the system. There is no permanent groundwater in the alluvium. As a comparison, groundwater levels in the underlying Rewan Group are ~17.5 mbGL (MBBE007) indicating disconnection between the alluvium and the deeper system. Groundwater in the alluvium is ephemeral and dependent on the input of surface water (following rainfall events). The 2023 groundwater updated model does not predict a change to the groundwater level in this unit as a result of the open cut development.

[3] mbGL – metres below ground level

4.3.2 Tertiary Sediments

The Tertiary sediments are recharged by direct infiltration from rainfall where these sediments are present at the surface. Short duration recharge also occurs via seepage from the alluvium (where present) for short periods following surface water flow events. However, due to the limited thickness of the Tertiary sediments in the vicinity of the Project area (maximum thickness of ~15 m) some infiltration occurs to the underlying hydrostratigraphic units.

To the west of the proposed pit is one monitoring bore (MBBE0002) screened in the Tertiary sediments (Figure 4.8). Groundwater was not encountered during the drilling and installation of this bore as part of the site investigation program. However, subsequent groundwater monitoring rounds have encountered groundwater within the bore, with the data indicating limited recharge to the Tertiary sediments. Groundwater levels varied between 11.5 to 11.9 mbGL for the period April 2021 to March 2023.

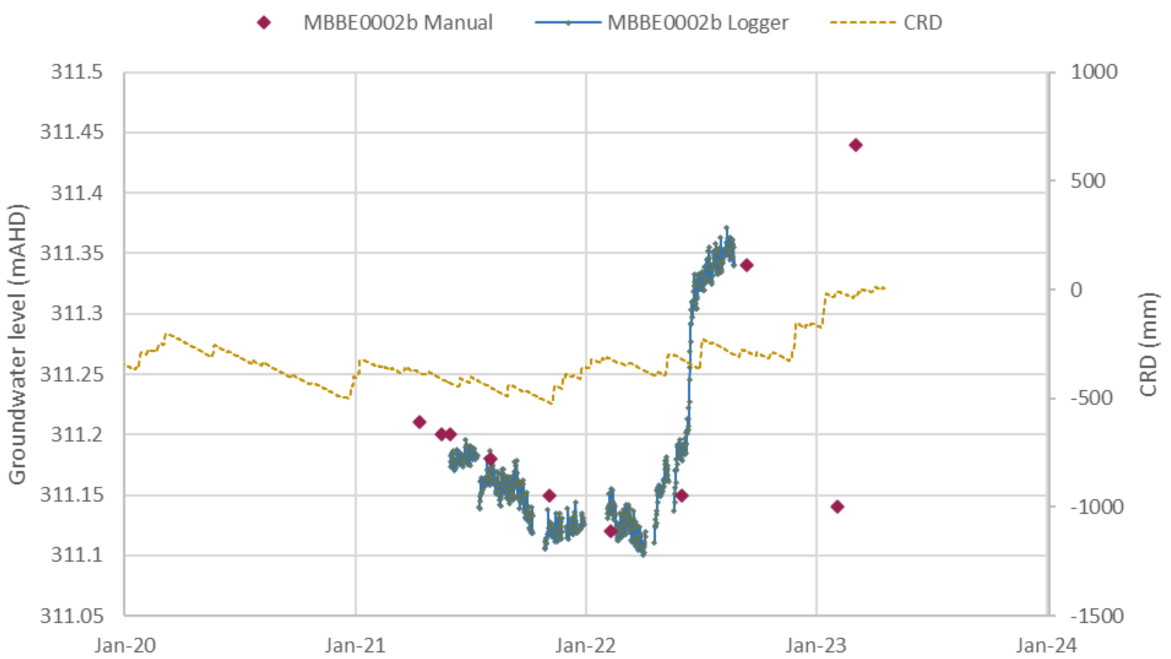


Figure 4.8 Groundwater Elevation Hydrograph – Bores Screened in the Tertiary Sediments

4.3.3 Tertiary Basalt

The Tertiary basalt typically underlies the Tertiary sediments and overlies the Rewan Group or Permian Coal measures, and as a single composite unit comprising massive and vesicular lava, tuff and ash flows. The upper basalt profile is highly weathered and comprises a basaltic clay.

Tertiary basalt is mapped to the south of the Project area and is present in the southwest of the lease. MBBE0003 was installed in the southwest corner of the mining lease, and this is also the only bore that intersected the Tertiary Basalt in the Project area. The basalt encountered in MBBE0003 is 15 m thick and dry (KCB 2021b). Groundwater is not observed in this monitoring bore.

4.3.4 Rewan Group

Groundwater level hydrographs from monitoring bores screened within the Rewan Group (Figure 4.9) comprise bores located approximately 4 to 5 km to the north of the Project area; EFGW2D, EFGW3D, EFGW4D, EFGW5D and IBGWR1; and two bores located within the Project area; BDW172(32) and MBBE0007. The groundwater level records from most of these bores indicate limited variability in levels over the duration of the monitoring period (Jan 2000 to March 2023), with limited seasonal variability, indicating limited hydraulic connection with overlying strata or the surface water system. Groundwater levels in EFGW5D (located northeast of the Project area) have fluctuated from ~285 mAHD to ~298 mAHD during the monitoring period.

Across the Project area, the Rewan Group is identified as the uppermost strata in the stratigraphic profile that hosts the regional groundwater level. The depth to groundwater level in the Rewan Group ranges from 17.5 mbGL to 27 mbGL across the Project area.

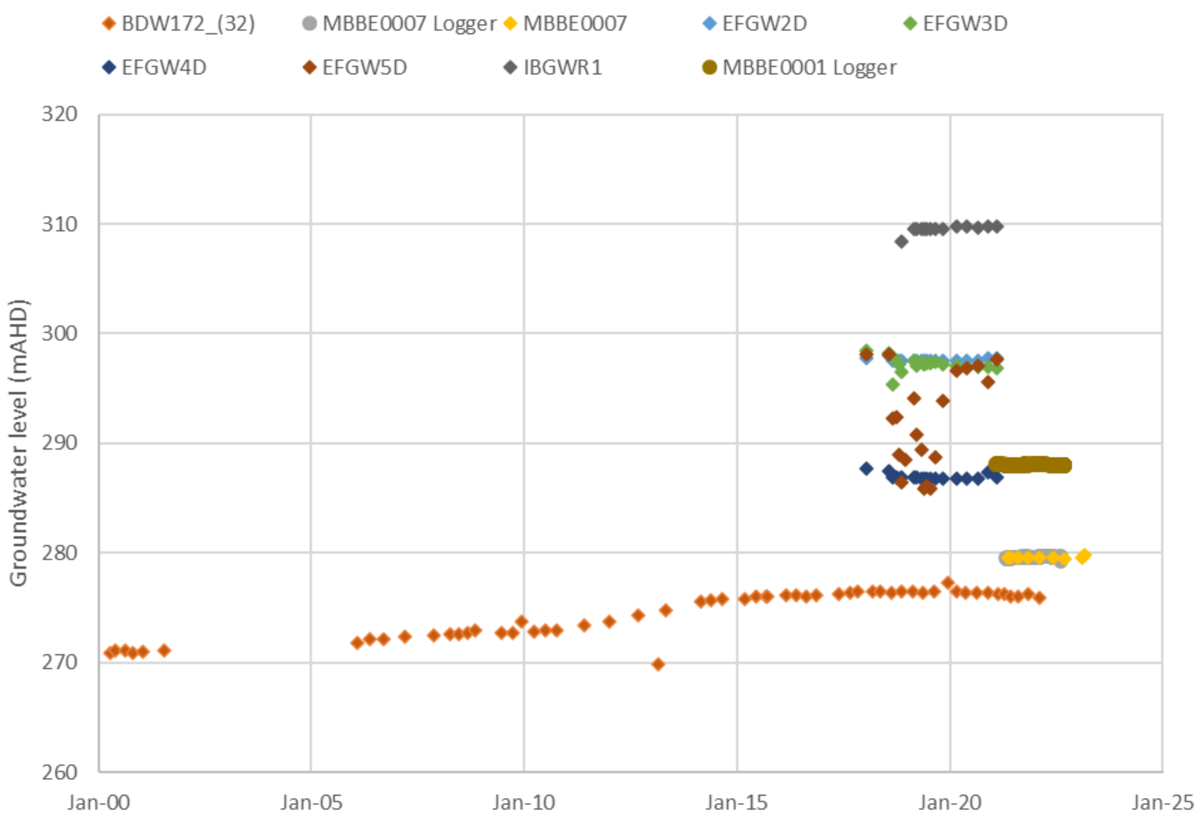


Figure 4.9 Groundwater Elevation Hydrograph – Bores Screened in the Rewan Group

4.3.5 Rangal Coal Measures

The groundwater level hydrographs for the Rangal Coal Measures (Figure 4.10) identifies limited changes in groundwater levels for the duration of the monitoring period, with the exception of monitoring bores located adjacent to mining activities where mine dewatering and groundwater level recovery trends are observed (e.g. BDW366P, BDW368P). There are also limited changes in water levels due to seasonal climatic variability, indicating limited connectivity with overlying strata and the surface water system.

Conceptually, the interpreted groundwater flow direction in the Permian coal measures is towards west-southwest, which is a subdued reflection of the surface topography. However, historical coal mining activities in the vicinity of the Project area has resulted in zones of depressurisation in the groundwater, particular in the vicinity of adjacent residual open pit voids where pit lakes, in connection with the groundwater system, are present. These pit lakes have caused a reduction in the potentiometric surface creating a hydraulic gradient towards the pit lake. Therefore, the current groundwater flow direction in the vicinity of the Project area is a reflection of this hydraulic gradient, with groundwater flowing towards these pit lakes (i.e., towards the northwest).

Groundwater levels fluctuated between 10.9 mbGL and 21.0 mbGL for the period January 2006 to March 2023.

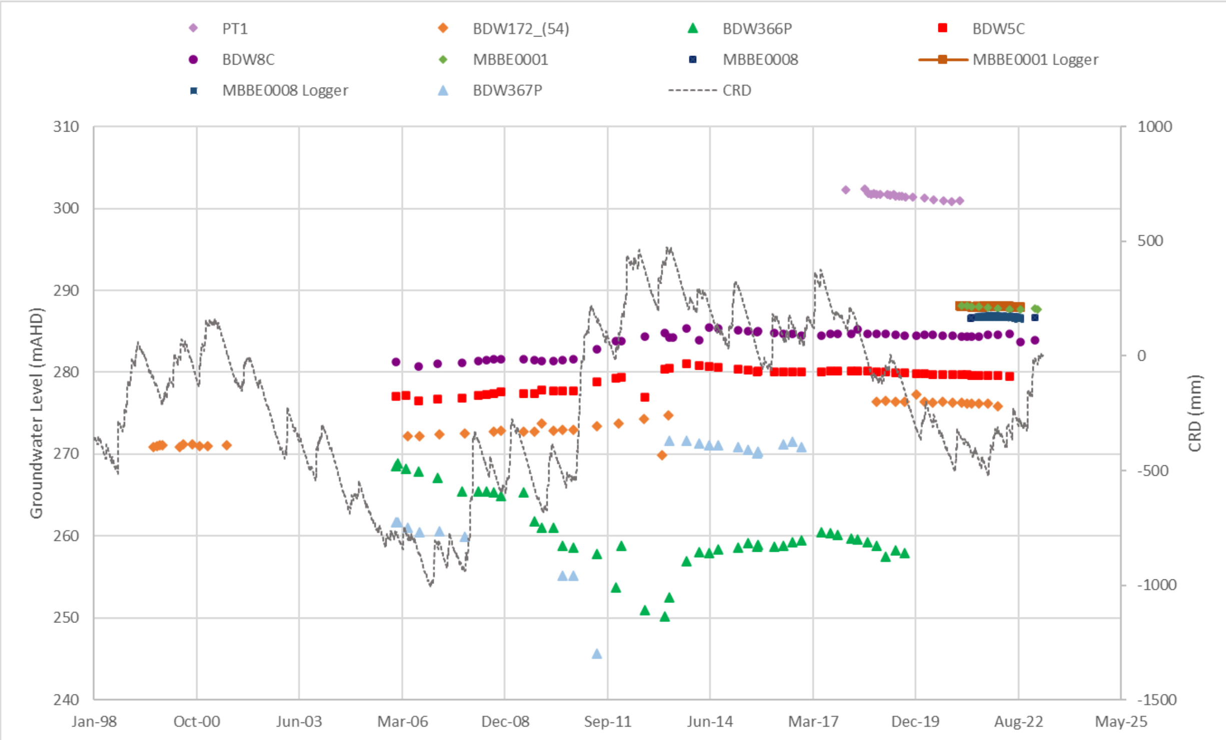


Figure 4.10 Groundwater Elevation Hydrograph – Bores Screened in the Rangal coal measures

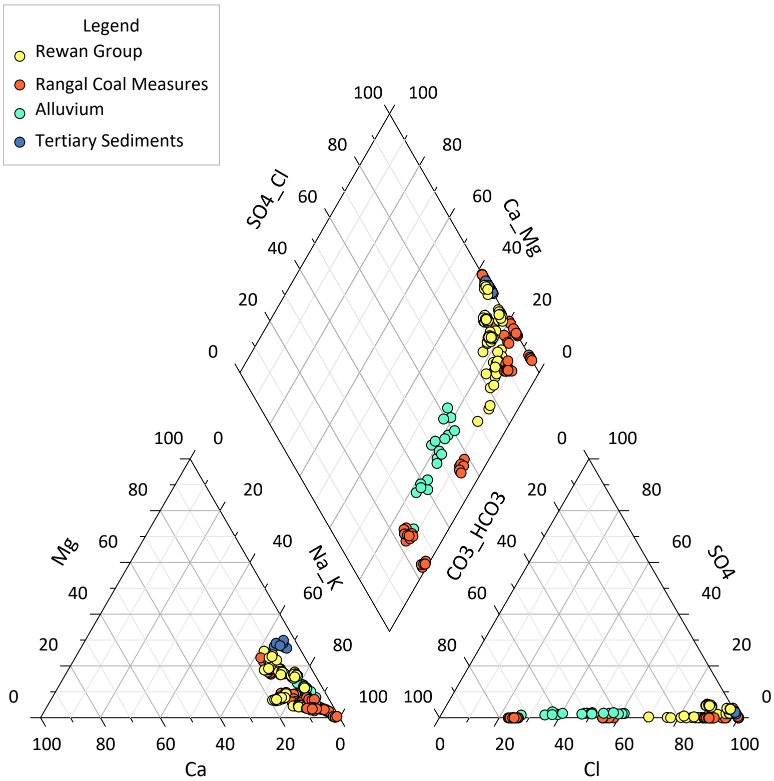
4.4 Groundwater Quality

Groundwater quality data provides useful information on the hydrogeological regime, as it is influenced by interaction with the aquifer matrix, and groundwater recharge/discharge processes. Groundwater quality samples have been collected from the various monitoring bores between 2006 and 2023 and are presented in Figure 4.11.

Previous site investigations identified that groundwater was accessible only in the Tertiary sediments, Rewan Group and Rangal Coal Measures within the Project area.

Piper and Durov plots provide an understanding of the hydrochemical composition of the groundwater, with the addition of pH and EC as additional differentiators. The plots for the groundwater quality from bores in the vicinity of the Project area (Figure 4.11) indicates that the proportion of major ionic constituents for the three main hydrostratigraphy units are relatively similar, with the dominant water types being Na/K–SO_4 to Na/K–HCO_3.

A review of groundwater quality data from the current Project groundwater monitoring network (as per EA0002465) indicates that the water quality in the Project area remains relatively stable, and the key parameters noted in the EA are within baseline levels.



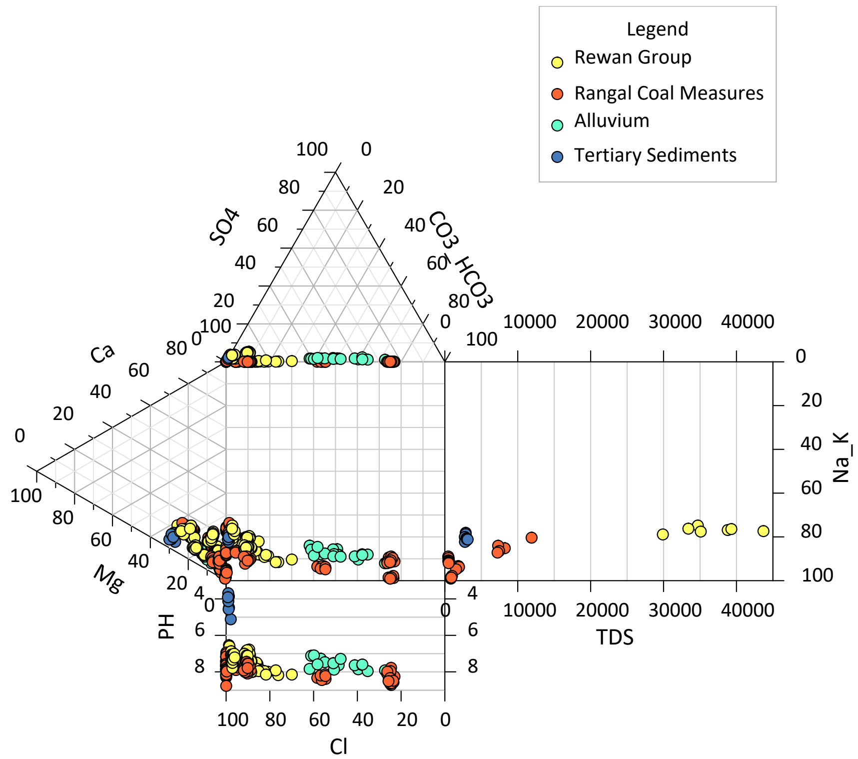


Figure 4.11 Piper and Durov Plots for Groundwater Samples Collected across the surrounding Project Area from 2006 to 2023

Figure 4.12, Figure 4.13, and Figure 4.14 present the timeseries plots of pH, EC and sulfate for groundwater sampled from monitoring bores across the Project area.

Generally, neutral to slightly alkaline groundwater conditions exist. Bore MBBE0002b recorded declining pH values ranging from 5.12 to 3.69 and is the only bore from the monitoring bores that recorded an acidic pH.

Figure 4.13 presents the EC measured at monitoring bores across the BME Project area between 2004 and 2023. Values range between ~850 to 48,500 µS/cm.

Groundwater from MBBE0007 displayed an EC of 48,600 µS/cm (recorded in February 2022), before declining for the remainder of the reporting period. MBBE0001 also recorded an increase in EC with a concentration of 909 µS/cm in September 2022. However, these changes are not of concern as these increases correlate with natural variations in the EC concentrations.

A time series graph of sulfate concentrations is presented in Figure 4.14. Bore MBBE0002b, in the Tertiary sediments, showed declining sulfate concentrations for the monitoring period. Sulfate concentrations in the groundwater from Rangal Coal Measures bores remained stable at <1 mg/L, while MBBE0007 displayed a slight increasing trend, ranging from 876 mg/L to 956 mg/L.

Other monitoring bores screened within Rangal Coal Measures (BDW5C, BDW8C, and MBBE0008) have neutral to alkaline pH, and have stable EC values except for BDW5C which recorded a rise in EC in February 2022 before declining in June 2022. This bore has since been mined out.

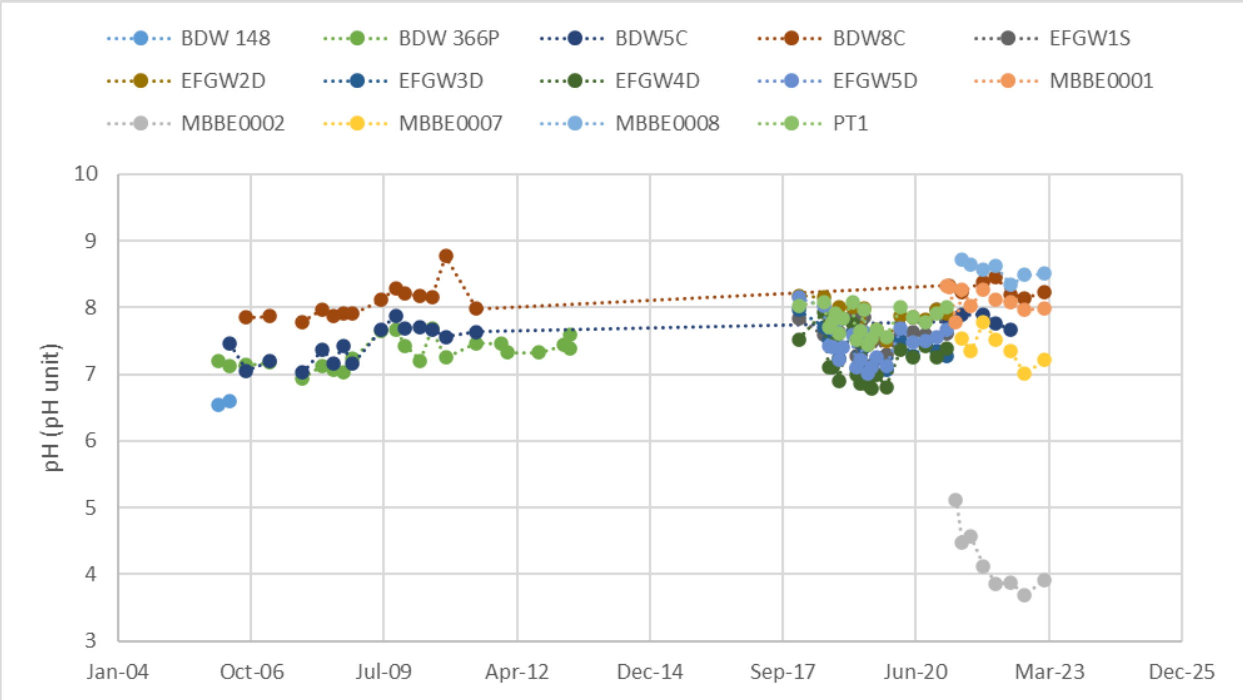


Figure 4.12 Transient pH Groundwater Quality Results

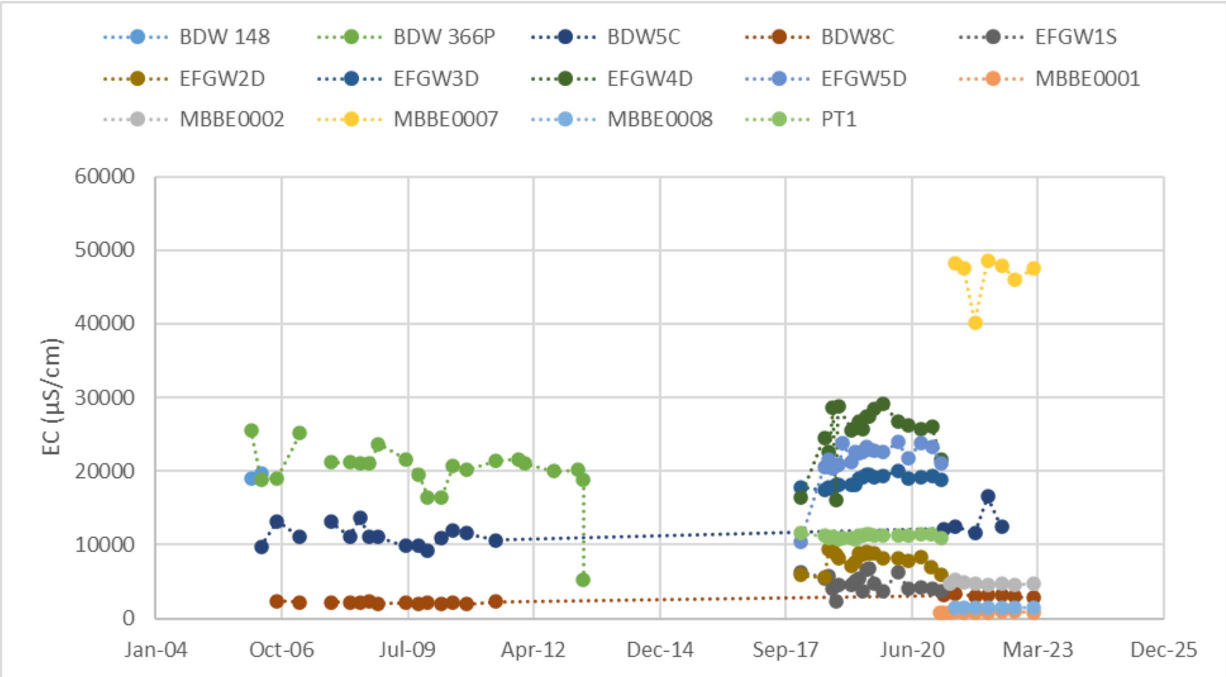


Figure 4.13 Transient EC Groundwater Quality Results

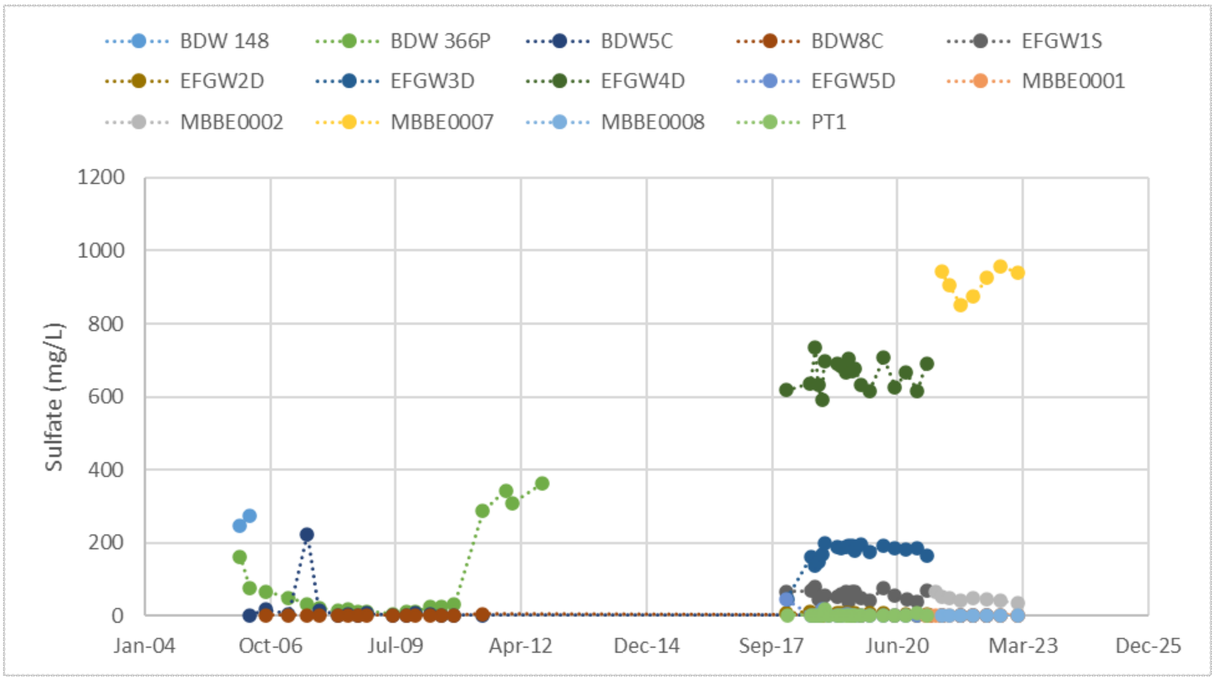


Figure 4.14 Transient Sulfate Groundwater Quality Results

4.5 Receptors

4.5.1 Registered Groundwater Users

A total of 43 registered bores are present within the 5 km buffer of the Project. Figure 4.15 presents the location of these registered bores, which comprise:

- 1 bore screened in the Quaternary alluvium;
- 3 bores screened in in the Tertiary sediments;
- 8 bores screened in the Tertiary basalt;
- 3 bores screened in the Rewan Group;
- 15 bores screened in the Rangal Coal Measures;
- 4 bores screened in the Blackwater Group; and
- 9 bores screened in the Fort Cooper Coal Measures.

Of the 43 registered bores two bores are recorded as water supply bores in the Department of Regional Development, Manufacturing and Water (DRDMW) groundwater bore database, with the remainder being mine monitoring bores. RN81908 is inferred to be screened within the Rewan Group, and RN105678 is inferred to be screened within the Tertiary basalt.

Further investigations into the water supply bores (RN81908 and RN105678) have been completed by the proponent, which included site inspections and discussions with the pastoral lease manager. The site inspections did not identify the presence of the bores or any associated infrastructure for groundwater abstraction; and discussion with the pastoral lease manager indicated that there are no water supply bores located within or in the immediate vicinity of ML70257. Therefore, these bores will not be considered as potential third-party groundwater supply bores (i.e. potential groundwater receptors) as part of this assessment.

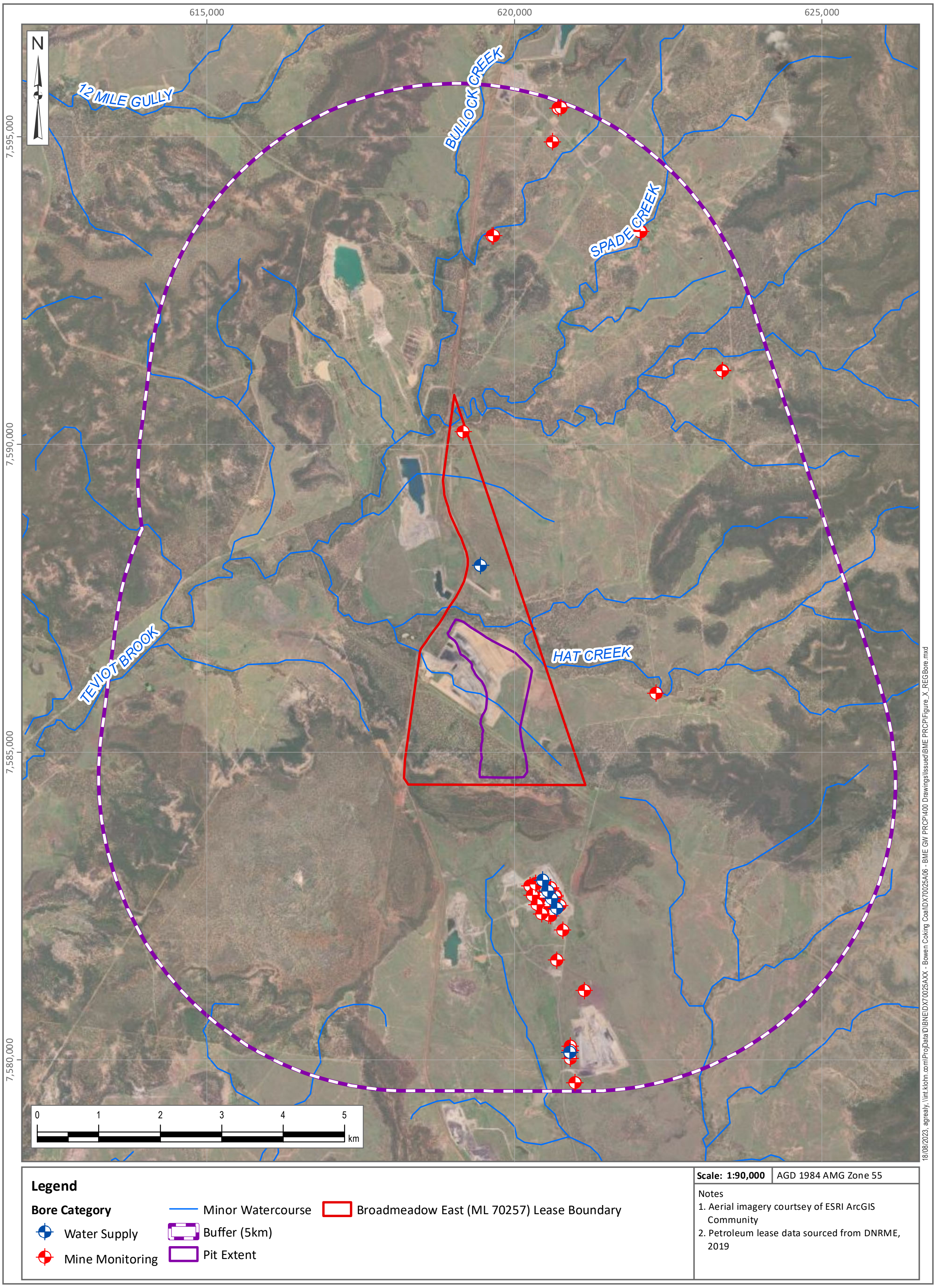


Figure 4.15 Location of Registered Groundwater Bores within 5 km of the Project area

4.5.2 Groundwater and Surface Water Interaction

Public domain information of mapped springs and wetlands (DNRME 2023), indicate that there are no known springs or wetlands located within 5 km of the project area.

4.5.3 Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystem (GDE) mapping provided in Queensland Globe (DNRME 2023) collates information from a number of sources into a central database, including published research and interpreted remote sensing data. These areas mapped in the GDE Atlas represent potential GDEs that access groundwater to meet all or some of its water requirements. This includes terrestrial vegetation, subsurface fauna communities and some vegetation which is associated with a surface water body.

Figure 4.16 presents the mapped GDE areas in the vicinity of the Project that have potential for GDEs to be present.

Based on the GDE database and mapping, Moderate Potential Aquatic GDEs as well as Moderate Potential Terrestrial GDEs are associated with the alluvium adjacent to Hat Creek and "low" potential GDE vegetation located in the southwest corner of the Project area.

Field verification surveys, completed as part of the Baseline Ecological Assessment for the EAR (Nitro Solutions 2020), confirmed the presence of several vegetation communities located within these mapped GDE areas. Areas of moderate GDE potential consisted entirely of RE 11.3.25 which was dominated by *Eucalyptus tereticornis* (Blue Gum). The communities associated with this vegetation species are restricted to the riparian corridors along Hat and Spade Creeks. The remaining areas mapped as having potential to contain terrestrial GDEs (TGDEs) have been field verified and determined to be unlikely to support TGDEs. The field verification process also determined the presence of Aquatic GDEs to be unlikely along Hat Creek. Further details on the field verification process is provided in the Baseline Ecological Assessment report (Nitro Solutions 2020).

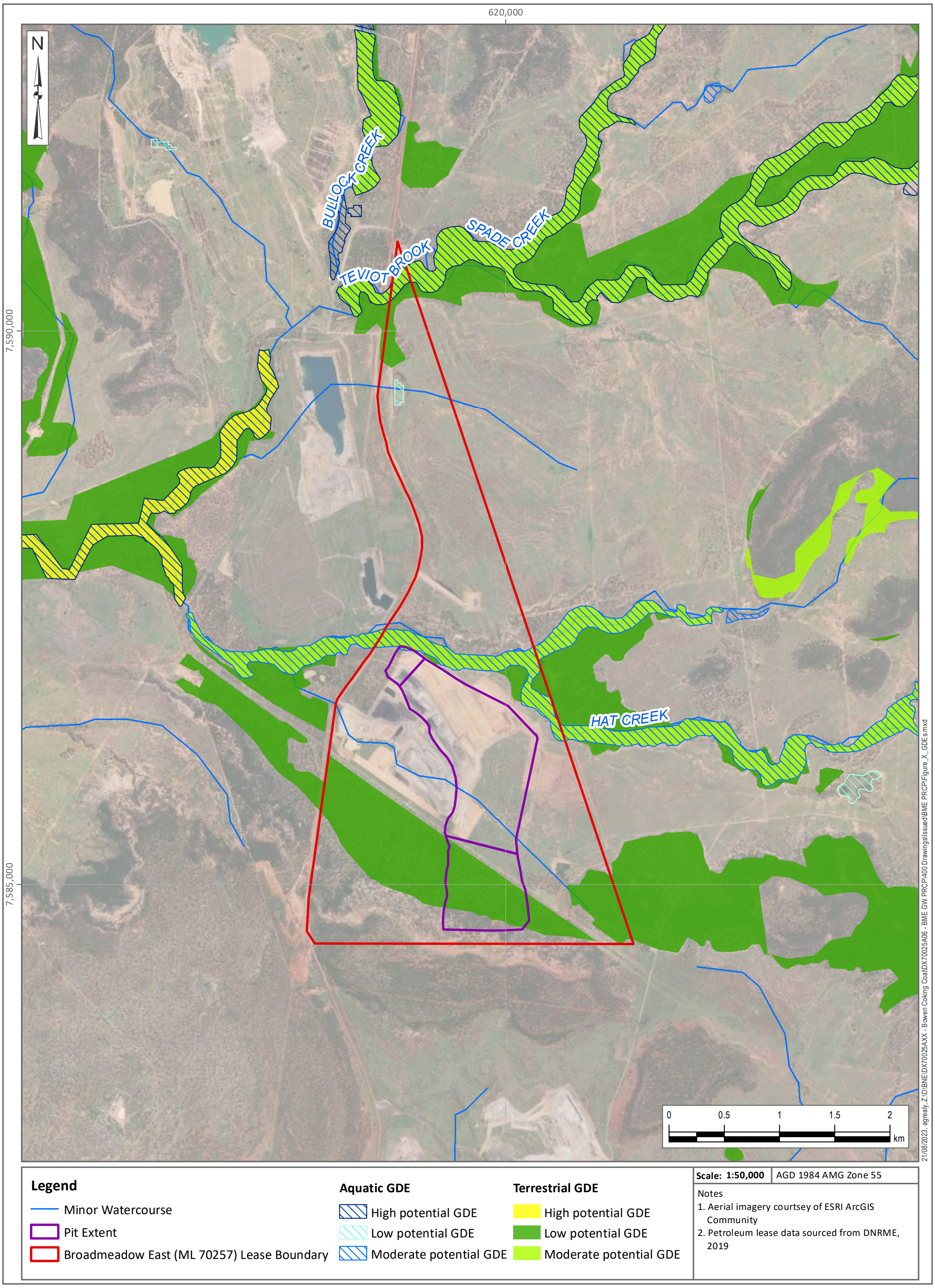


Figure 4.16 Desktop Review of Potential Terrestrial and Aquatic GDEs (from NitroSolutions)

5 NUMERICAL GROUNDWATER MODEL

A numerical groundwater flow model developed for the groundwater assessment that supported the BME regulatory approval process was used to support the development of the BME PRCP, by predicting changes in groundwater levels and flow during operations and into closure. The objectives of the model include:

- Estimating groundwater inflow / outflow in the final void; and
- Predicting the extent and area of influence of groundwater level drawdown associated with the final void.

The 3D numerical groundwater flow model was developed using the MODFLOW-USG platform to represent the conceptual hydrogeological model described in Section 4. A detailed description of the modelling methodology is provided in Appendix IV.

The numerical model represents the key hydrostratigraphic units with six layers. The area of the model extent is approximately 280 km^2. The model boundaries are defined by topography and hence coincides locally with groundwater divide conditions; which represents the northeast, northwest and southeast boundaries. The southwestern boundary of the model domain is located at a distance from the Project area.

The physical structure of the groundwater model was based on the detailed geological model provided by Zenith and RPM Global (formerly NitroSolutions), and datasets sourced from the public domain. Model development was supplemented by published geological maps, digital geological surfaces, DRDMW groundwater database, and information from surrounding mining operations and published approval documents.

5.1 Calibration

The Australian Groundwater Modelling Guidelines (Barnett et al. 2012a) were used to guide the calibration process. A detailed description of the model calibration is provided in Appendix IV.

The calibration model run was initiated as a steady-state simulation with boundary conditions applied to replicate known mining developments before March 2019. After this initial model conditioning period, the model then progresses to transient mode, during which quarterly stress periods are then implemented.

Model calibration was conducted based on groundwater level measurements. These measurements were compiled from 18 monitoring bores for which reliable water level measurements were available. In total, 192 individual measurements were used in the calibration process. A number of monitoring bores installed across the Project area in the shallow hydrostratigraphic units (e.g. Quaternary alluvium, Tertiary sediments, Tertiary basalt) are dry, indicating unsaturated conditions, and resulting in no groundwater level records. Despite the lack of groundwater level records from the upper hydrostratigraphic units, this unsaturated characteristic also provided a calibration criteria for the model.

The calibrated groundwater model was used to predict groundwater inflows, changes in groundwater levels and the associated groundwater level drawdown extent in response to the remaining mining operations and post-closure conditions.

5.2 Predictive Modelling of Groundwater Flow

The simulation of post-closure groundwater conditions was undertaken to assess the final Northern Pit and Southern Void water elevation within the proposed post-closure landform. Final pit void lake elevations were simulated by Engeny using a water balance model, as part of the surface water assessment. This water balance incorporated all contributing fluxes to the pit voids, including the groundwater inflow. The post-closure groundwater inflow flux was simulated for a range of pit void lake elevations, from the maximum inflow rate when groundwater levels are at the base of the pit to the pre-mining groundwater level elevation where no groundwater inflow is observed. These fluxes were provided to Engeny as inputs for the surface water modelling.

Post-closure steady-state elevations of the pit voids associated with the final landform were calculated by Engeny from the water balance model. These steady-state elevations in the voids were applied to the groundwater model, using a General Head Boundary (GHBs) to simulate the post-closure groundwater conditions. Recharge and evaporation were not applied to the void, as this was captured in the Engeny water balance model. This simulation was conducted for a 500-year duration, using climate data provided by Engeny, to allow surrounding groundwater levels to recover to post-closure equilibrium / steady-state conditions.

The post-closure water levels are provided in Figure 5.1 for 10-, 50-, 100- and 500-years post-closure. The results show that the void is predicted to develop as a groundwater sink, with groundwater flowing towards the void. A summary of the potential impacts to the groundwater resource associated with the post-closure landform and recovered groundwater levels is provided in Section 6.

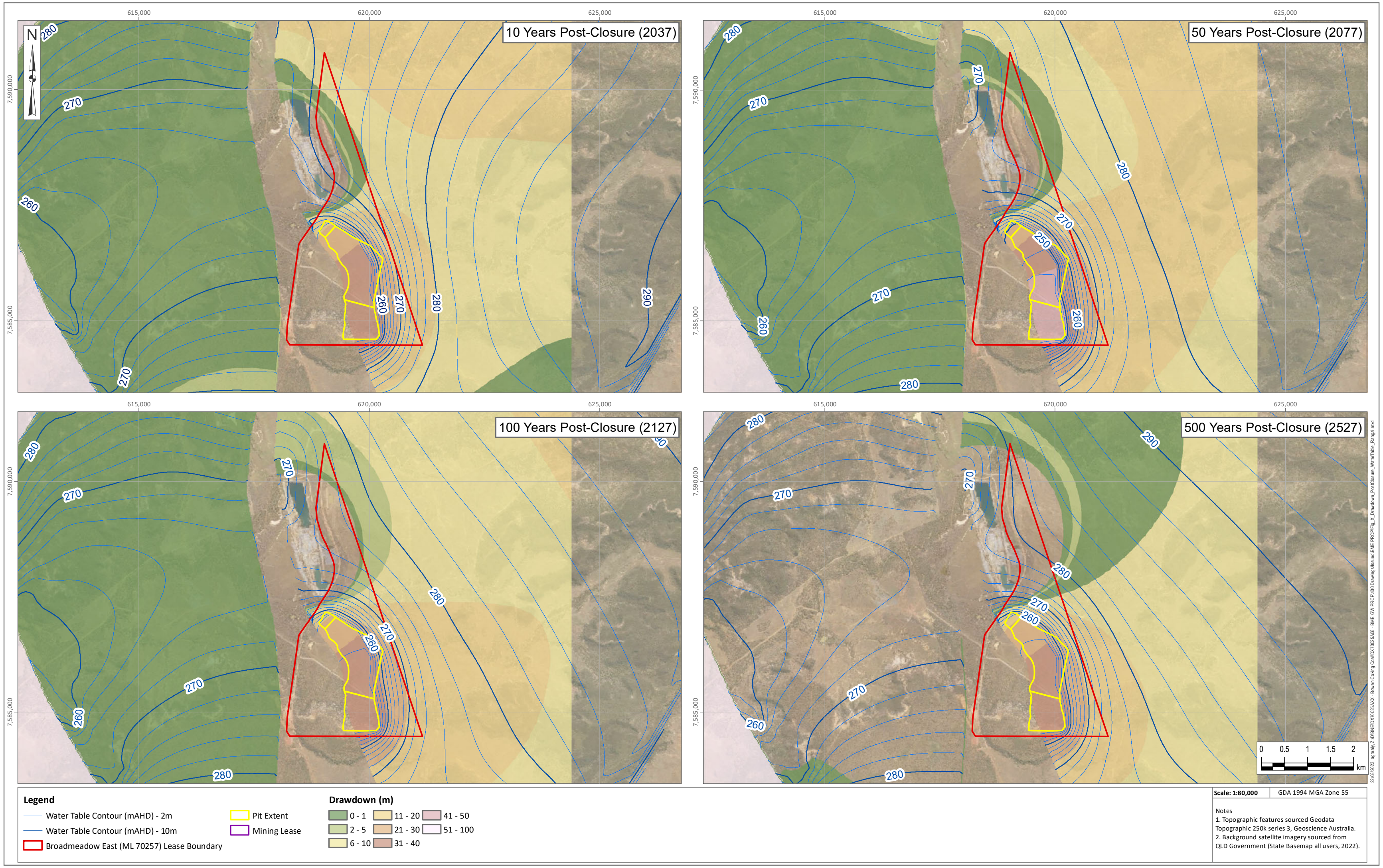


Figure 5.1 Post-Closure Drawdown and Elevation for Rangal coal measures – 10-, 50-, 100- and 500-Years Post-Closure

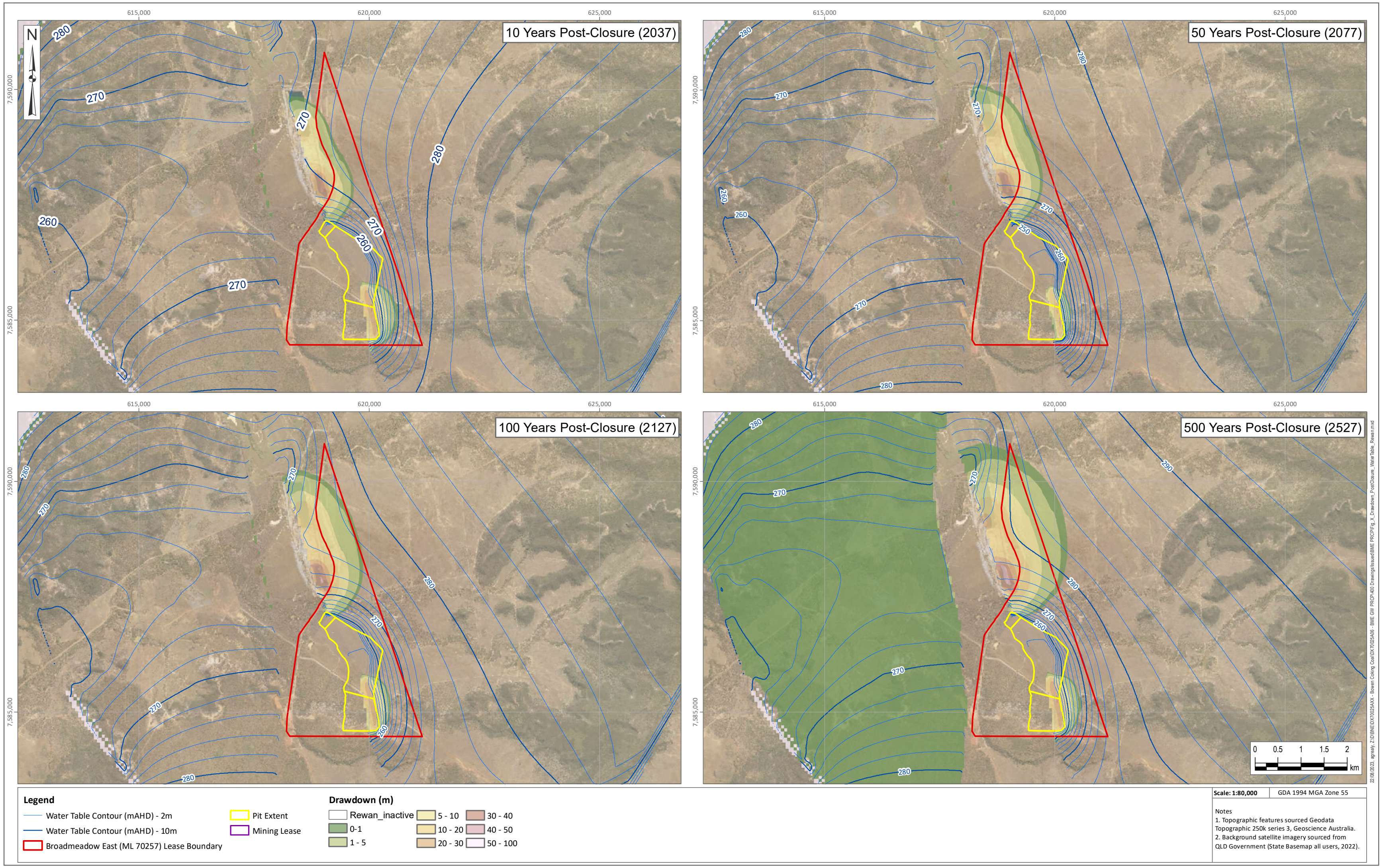


Figure 5.2 Post-Closure Drawdown and Elevation for Rewan – 10-, 50-, 100- and 500-Years Post-Closure

5.3 Climate Change Scenario

The post-closure simulation was undertaken using climate predictions from the CSIRO/BOM "*Climate Change in Australia. Climate Information, Projections, Tools and Data"* for the Australia East Coast Cluster and subcluster. These climate predictions represent the "high level projections" for rainfall and evapotranspiration from the CSIRO/BOM study and allows the assessment of potential impacts to groundwater resources as a result of climate change.

A total net reduction in rainfall of 5% was incorporated in the rainfall recharge calculations and applied to the BME model. The 5% reduction in the annual rainfall takes into account the 2% reduction in annual rainfall predictions and the increase in evapotranspiration.

Results from the model prediction with current predicted climate change show very little to no impact on groundwater levels (Figure 5.3) at compliance monitoring bore MBBE0007.

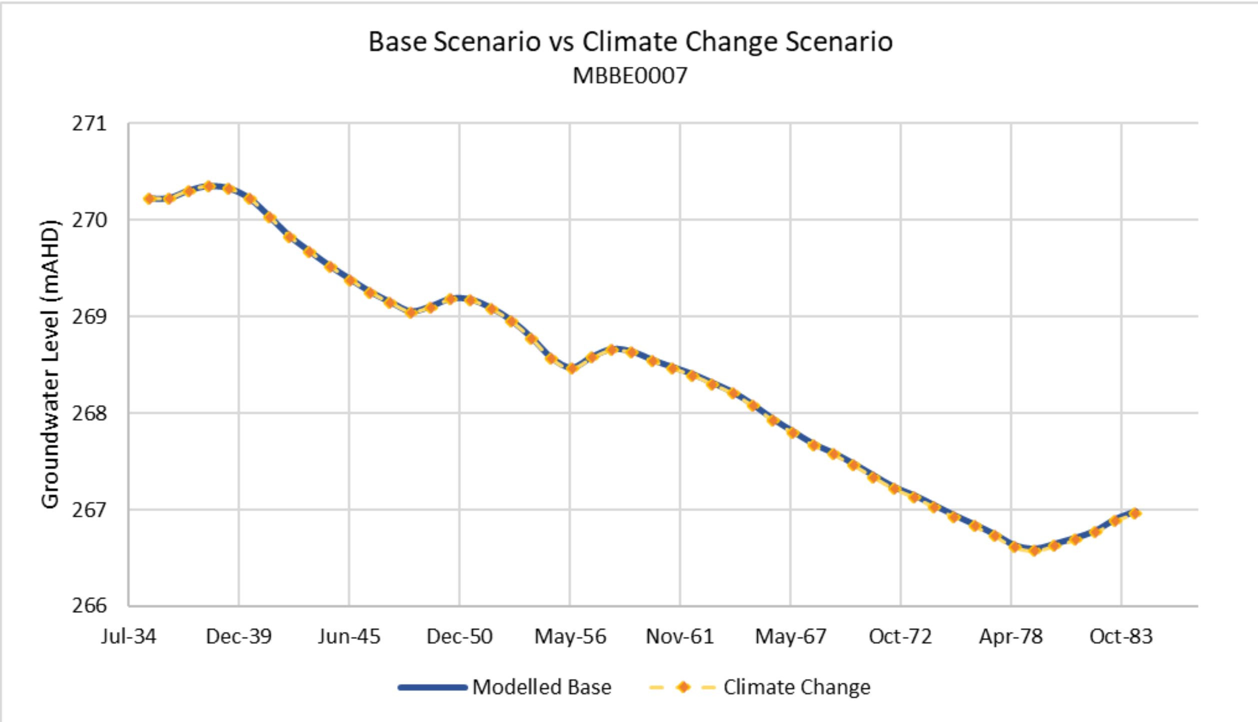


Figure 5.3 Comparison of Climate Change Scenario vs Base Scenario

6 IMPACT ASSESSMENT

6.1 Post-Closure Groundwater Levels

The post-closure groundwater levels for the Rangal Coal Measures and the Rewan Group are provided in Figure 5.1 and Figure 5.2, respectively. The results show that the void is predicted to develop as a groundwater sink, with groundwater flowing towards the void.

The Southern Void is predicted to act as a groundwater sink, with localised groundwater flow from the south and southwest towards the final void.

Two formations indicate changes in groundwater levels as a result of the mining activities in the Project area; the Rewan Group and the Rangal Coal Measures.

Along the Hat Creek some Moderate Potential Aquatic GDEs as well as Moderate Potential Terrestrial GDEs are associated with the alluvium. However, no drawdown of groundwater levels is expected for the alluvium, and therefore no impact is expected on the GDEs.

Given the ephemeral nature of the alluvium and the lack of hydraulic connection with the underlying formations, no impact on groundwater receptors associated with the alluvium is predicted.

6.2 Post-Closure Groundwater Quality

Changes in local groundwater quality associated with the post-closure landform may potentially occur if former voids behave as a 'source[4]' rather than a 'sink'[5].

The South Void is predicted to result in a groundwater sink following the recovery of groundwater levels to post-closure equilibrium conditions. Therefore, outflow from the void to the surrounding groundwater system is not predicted. As a result, the water quality of the void water, is not predicted to impact the surrounding environment and associated environmental values. BME has a number of groundwater trigger values in place for key analytes including pH, sulfate, chloride and dissolved metals, designed to detect potential changes in groundwater quality and indicating potential impact. These trigger levels remain relevant into the closure period.

6.3 Potential Impacts to Environmental Values

Groundwater hosted in the hydrostratigraphic units underlying the BME Project area is generally of a poor quality with low yields and high salinity. There are limited beneficial uses for the groundwater, which is supported by the limited number of water supply bores in the vicinity of the BME. Some bores have been identified as potential water supply bores and are located ~1.7 km south of BME, with one water supply bore in the northern portion of the mining lease. TGDE mapping across the Project area identified potential TGDEs located along Hat Creek (Section 4.5). The potential TGDEs are generally associated with the alluvium aquifers. There is no predicted change to groundwater quality in the alluvium of Hat Creek and no predicted change to

[4] Voids become sources when water levels rise to above pre-mining groundwater levels.
[5] Voids are referred to as sinks when the surrounding groundwater system flows into them.

the groundwater levels during the closure period. Therefore, no discernible impacts to the potential TGDEs are predicted.

The potential impact to environmental values (refer to Table 2.1) from the BME post-closure landform is considered to be low to negligible.

7 CLOSING

We would like to thank you for the opportunity to work on this assignment. Should you have any questions, please do not hesitate to contact the undersigned.

KCB AUSTRALIA PTY LTD.

Carly Waterhouse
Senior Hydrogeologist, Project Manager

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APPENDIX I

Monitoring Program

Appendix I – BME Monitoring Bore Details

Table I-1 Groundwater Monitoring Bores at BME

Bore ID	Location (GDA 20 Zone 55)		Screened unit	Pre-mining baseline standing water levels (mbTOC)[6]	Drawdown trigger levels (m)	Groundwater trigger elevation (mAHD)[4]	Frequency
	Easting (m)	Northing (m)					
Monitoring bores							
MBBE0008	620294	7585092	Rangal Coal Measures	19.59	5	282.62	Quarterly measurements of SWL[5] Quarterly EC and pH Six-monthly for remaining analytes
BDW172(54)[1]	619376	7586650	Rangal Coal Measures	19.83	35	234.52	
BDW8C[3]	619782	7585651	Rangal Coal Measures	21.54	63	217.61	
BDW5C[1]	619687	7586758	Rangal Coal Measures	15.74	5	271.4	
BDW172(32) [3]	619376	7586650	Rewan Group	13.32	7	269.03	
MBBE0002b[2]	618436	7585329	Tertiary Sediments	12.57	2	331.86	
MBBE0003[2]	618431	7584664	Basalt	-	5	-	
MBBE0004[2]	620205	7586976	Alluvium	-	2	-	
MBBE0006[3, 2]	619173	7587205	Alluvium	-	2	-	
Compliance bores							
MBBE0001 [1,3]	619884	7585428	Rangal Coal Measures	42.2	57	206.01	Quarterly measurements of SWL Quarterly EC and pH Six-monthly for remaining analytes
MBBE0007	620615	7586415	Rewan Group	24.9	23	249.92	

1. To be monitored until mined out.
2. Some bores are often dry and unavailable for water levels.
3. To be replaced in Q3/4 2023 due to location of bore in proposed pit footprint.
4. Groundwater trigger elevations are conversion of drawdown trigger levels to metres above Australian Height Datum (mAHD).
5. Quarterly or more frequently following the grant of EA0002465.
6. mTOC – metres below top of casing.

Table I-2 Groundwater quality limits*

Monitoring Point	Parameter	pH	EC	Sulfate (SO4)	Arsenic	Aluminium	Molybdenum	Selenium	Major ions
	Sample	Range	Max	Max	Max	Max	Max	Max	Interpretation only
	Unit	pH units	(µS/cm)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
MBBE0001		6.5-8.5	888.3	0.5	0.002	0.08	0.001	0.005	
MBBE0007			48,540	937.6	0.005	0.37	0.025	0.046	

**Table D2 in EA0002465*

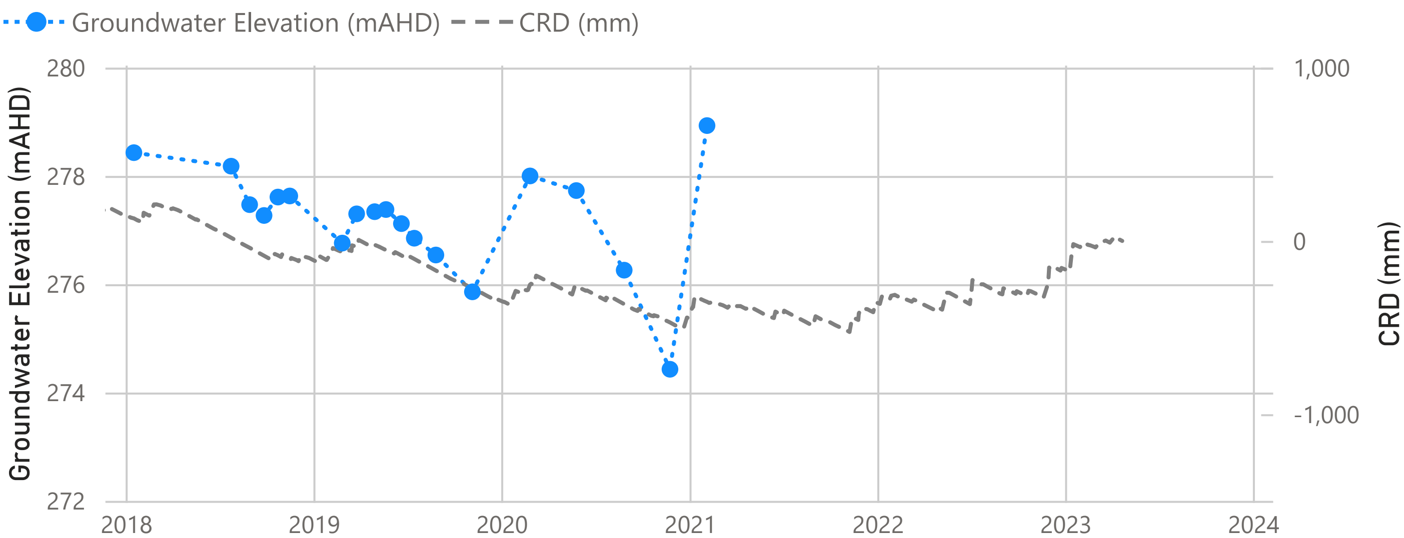
NOTE:
All metals must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal apply if dissolved results exceed trigger.
Triggers are based on 95th percentile results from all groundwater quality analyses from each monitoring bore.

APPENDIX II

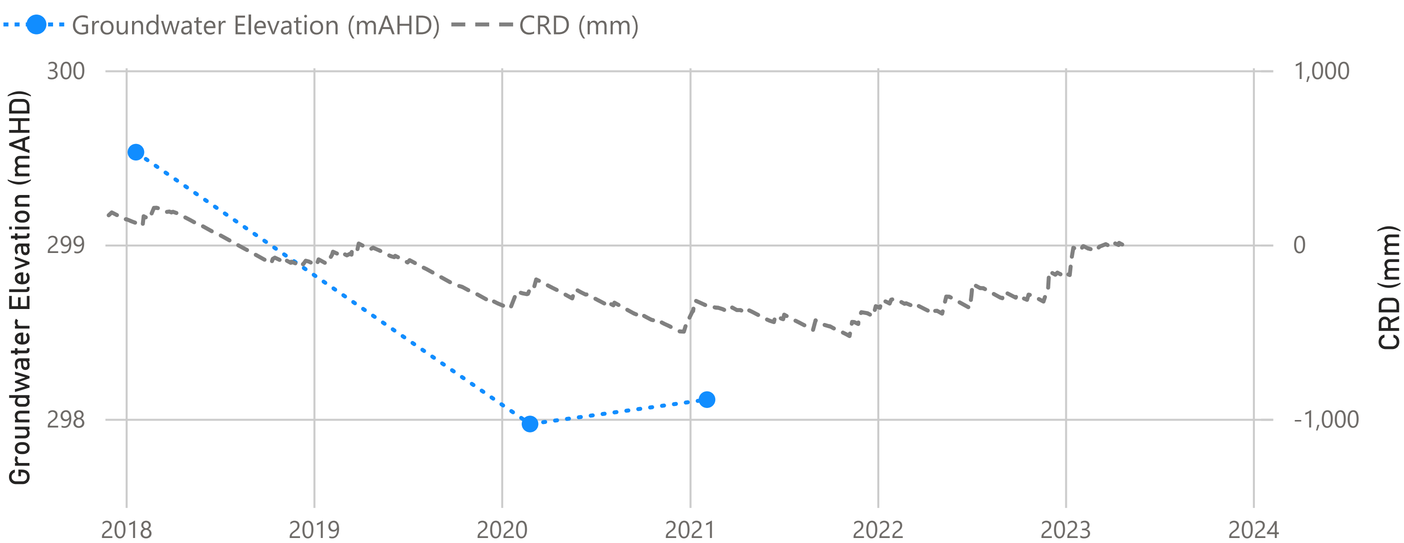
Groundwater Elevation Hydrographs

Alluvium

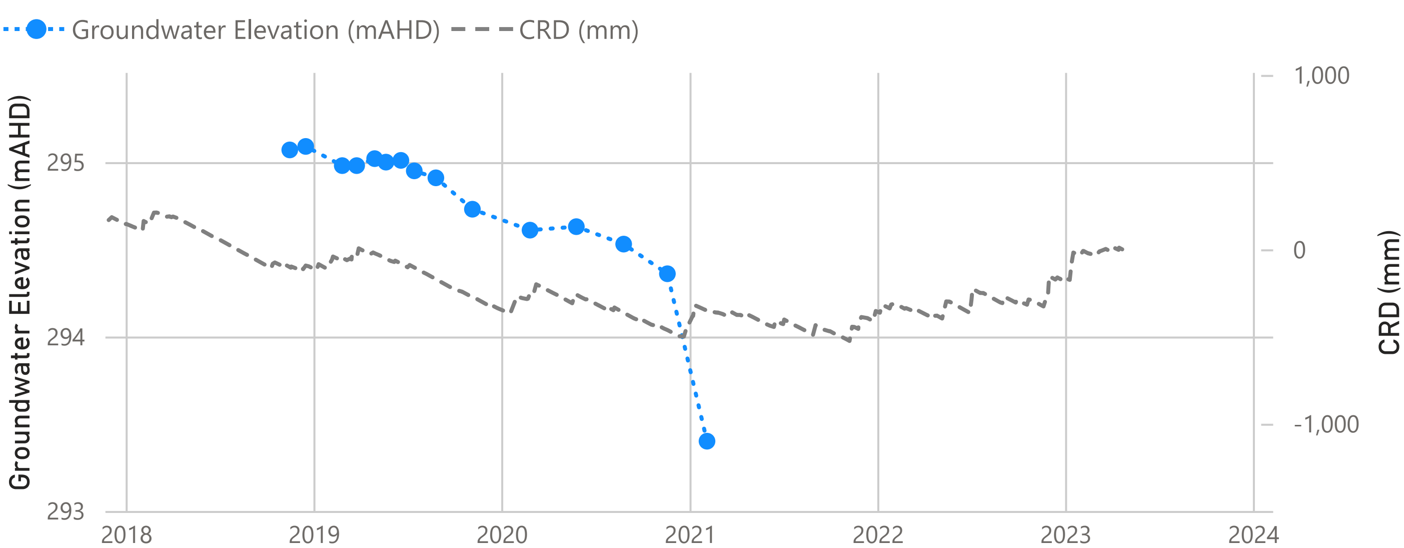
EFGW1S



EFGW4S

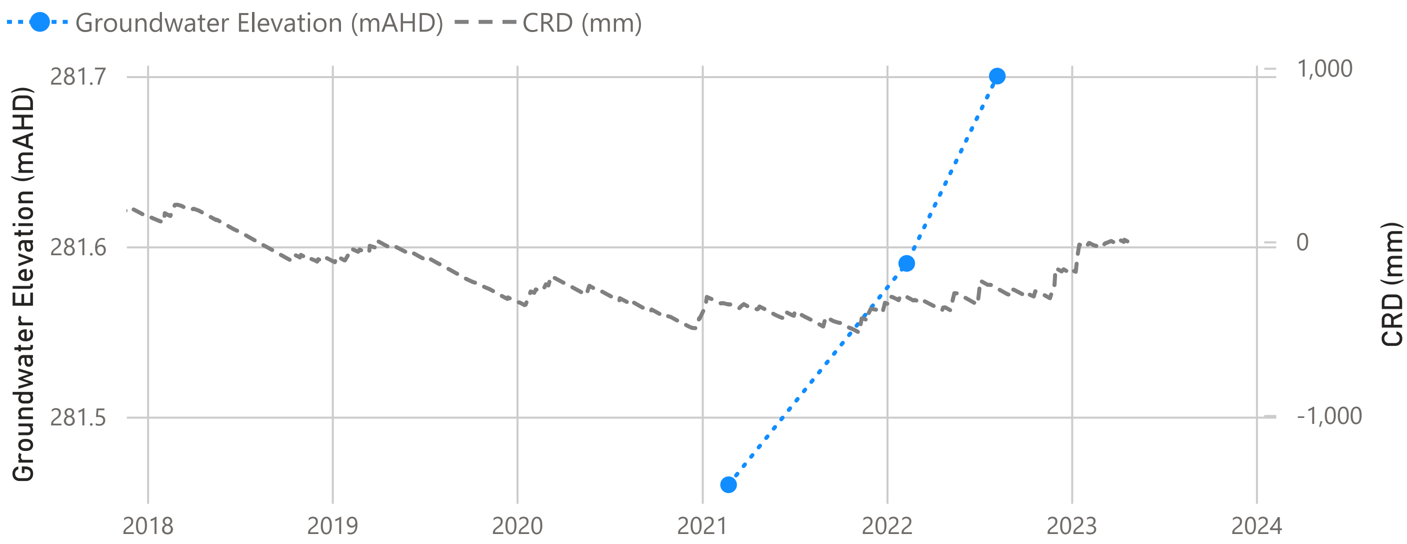


IBGWR2



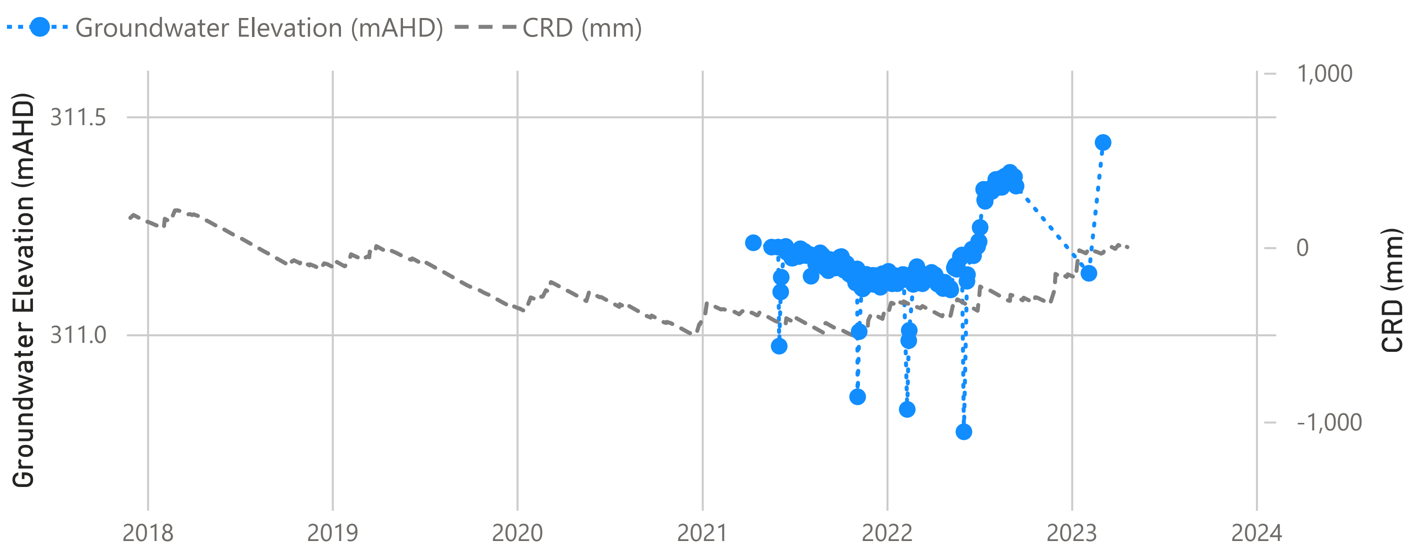
Alluvium

MBBE0006



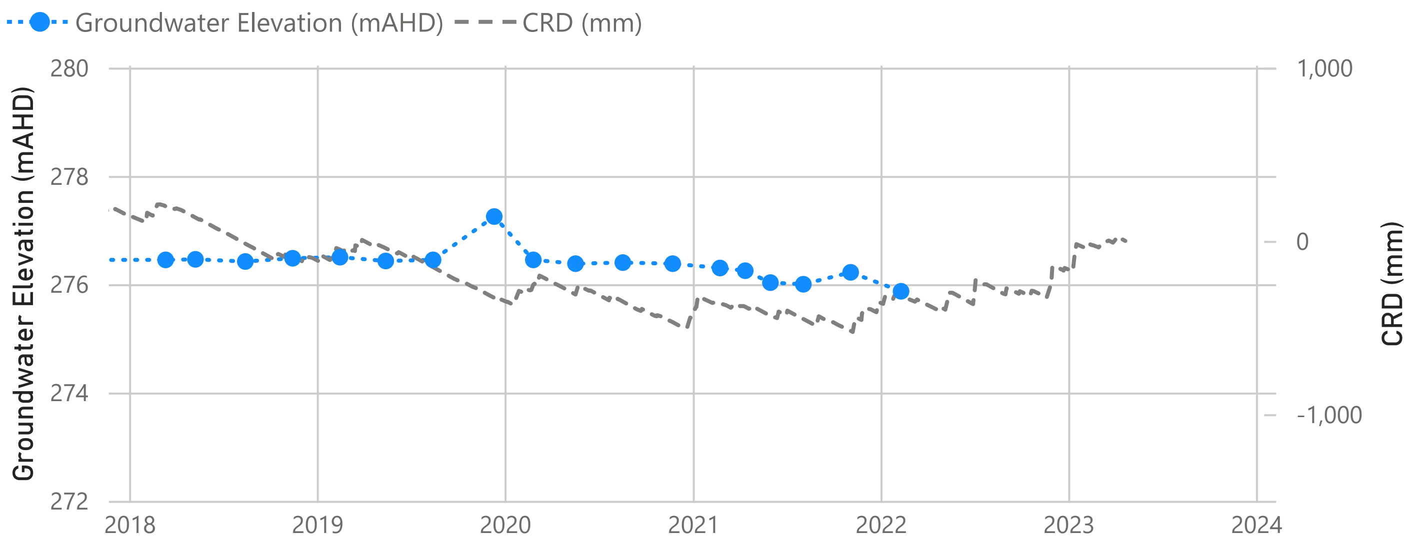
Tertiary Sediments

MBBE0002b

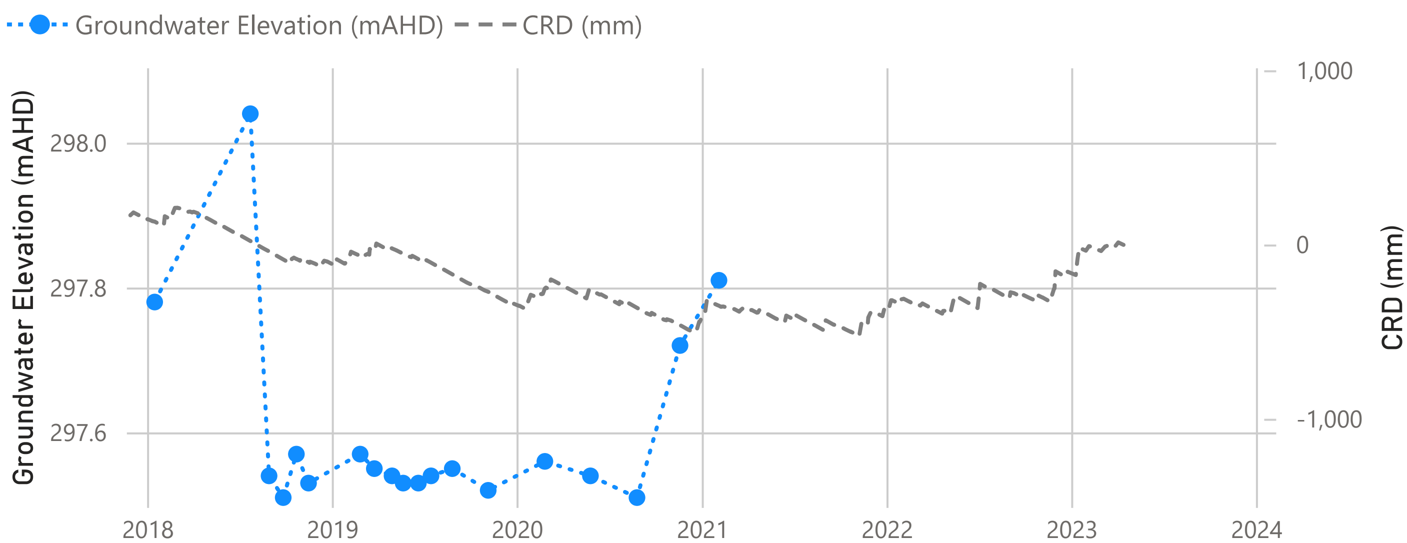


Rewan Group

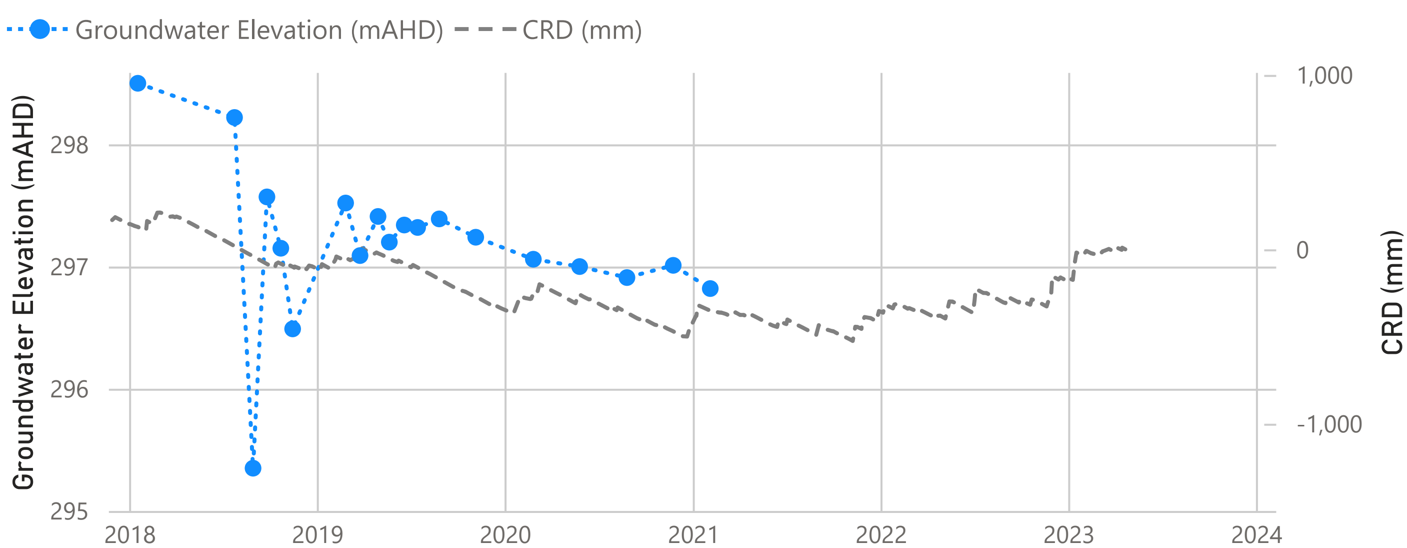
BDW172_(32)



EFGW2D

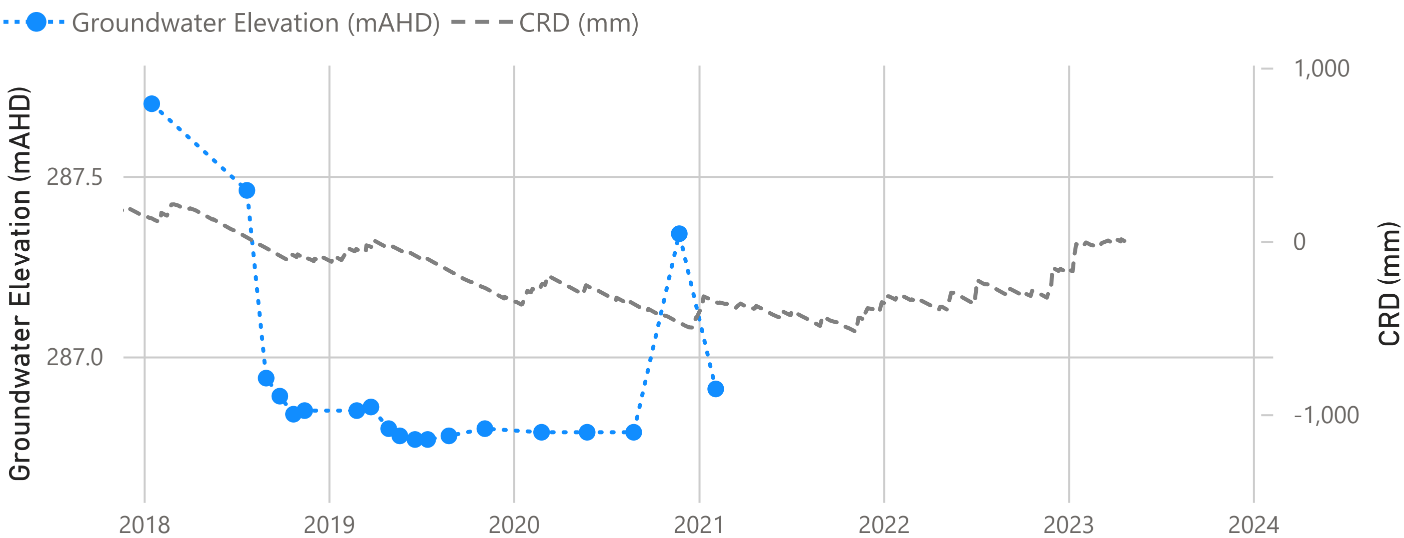


EFGW3D

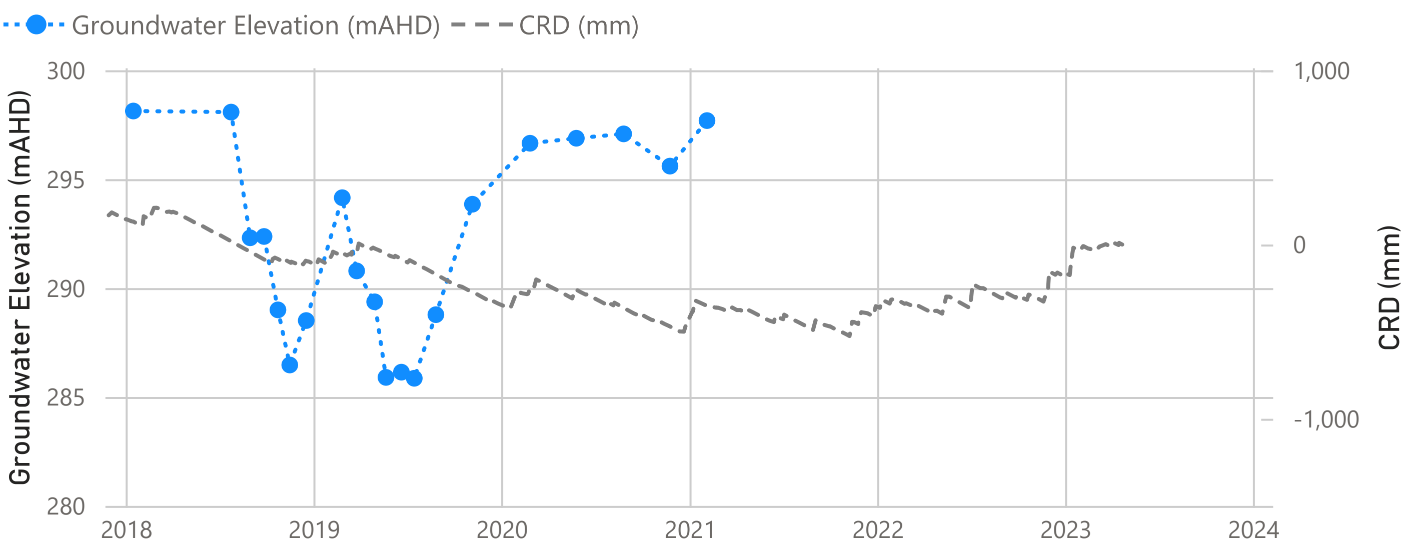


Rewan Group

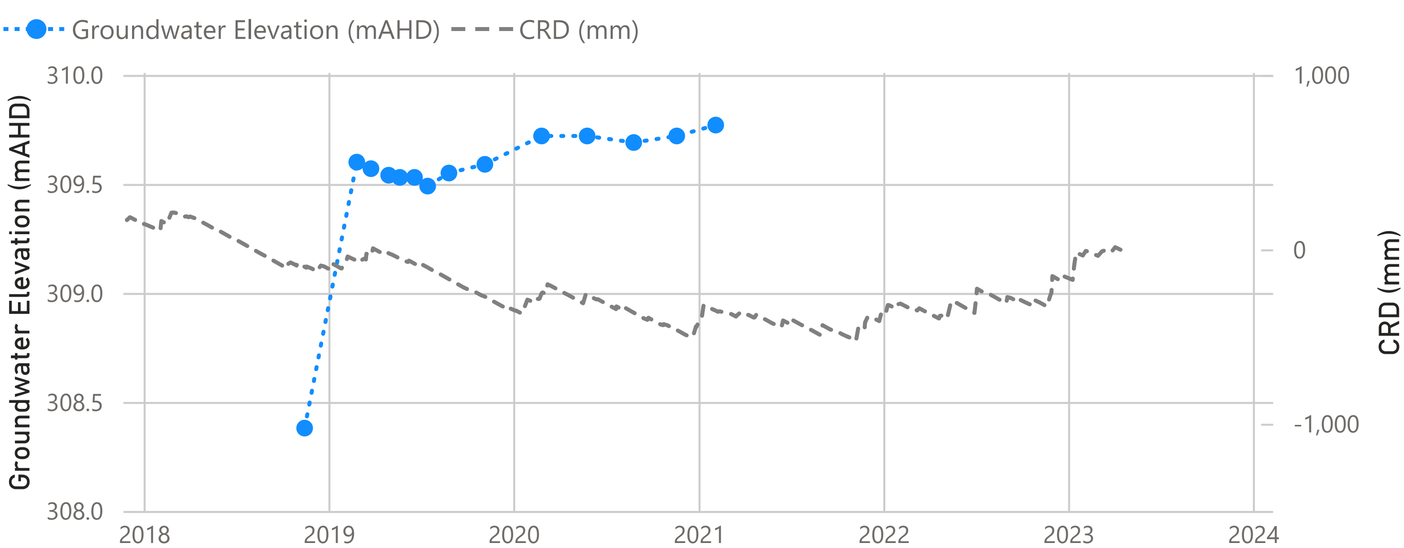
EFGW4D



EFGW5D

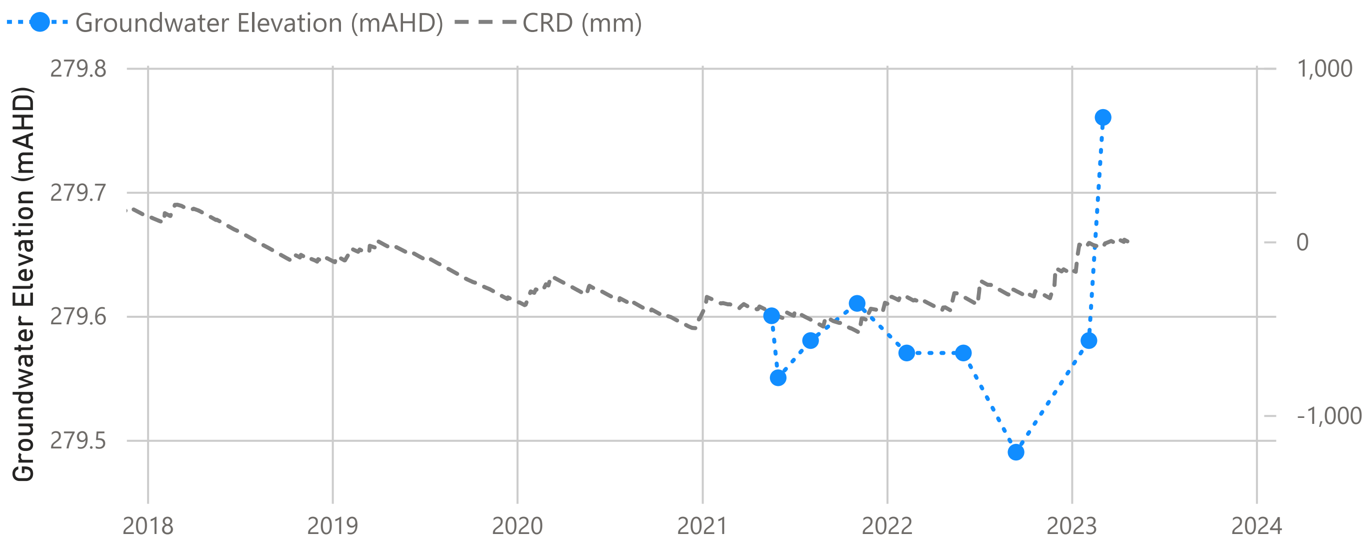


IBGWR1



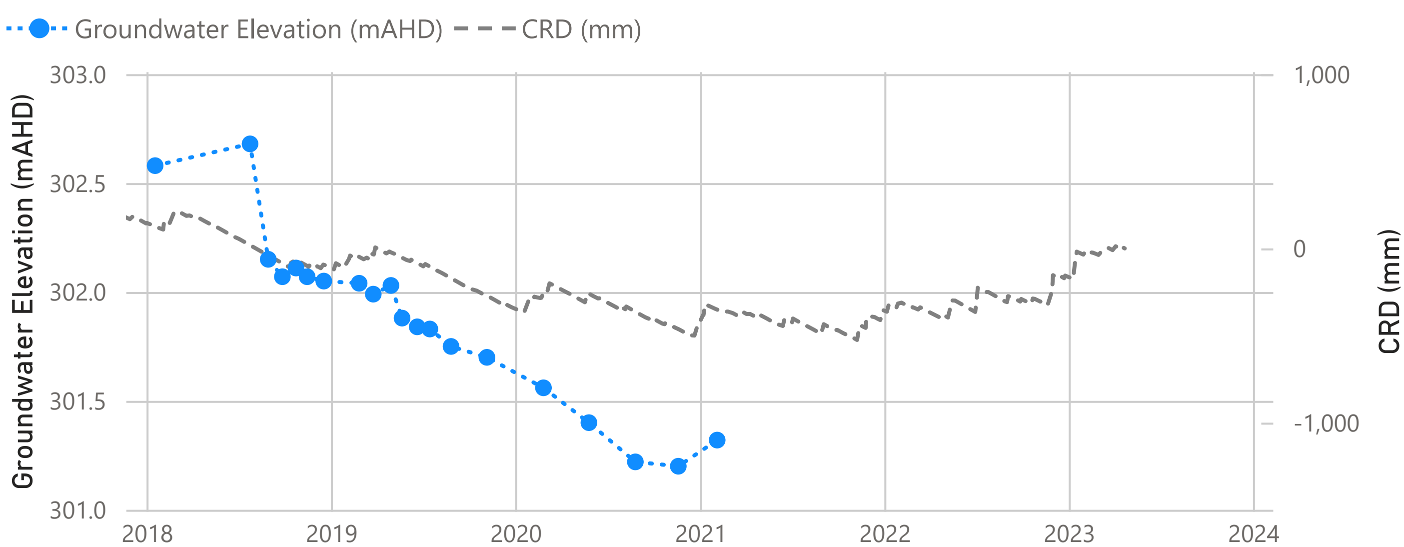
Rewan Group

MBBE0007



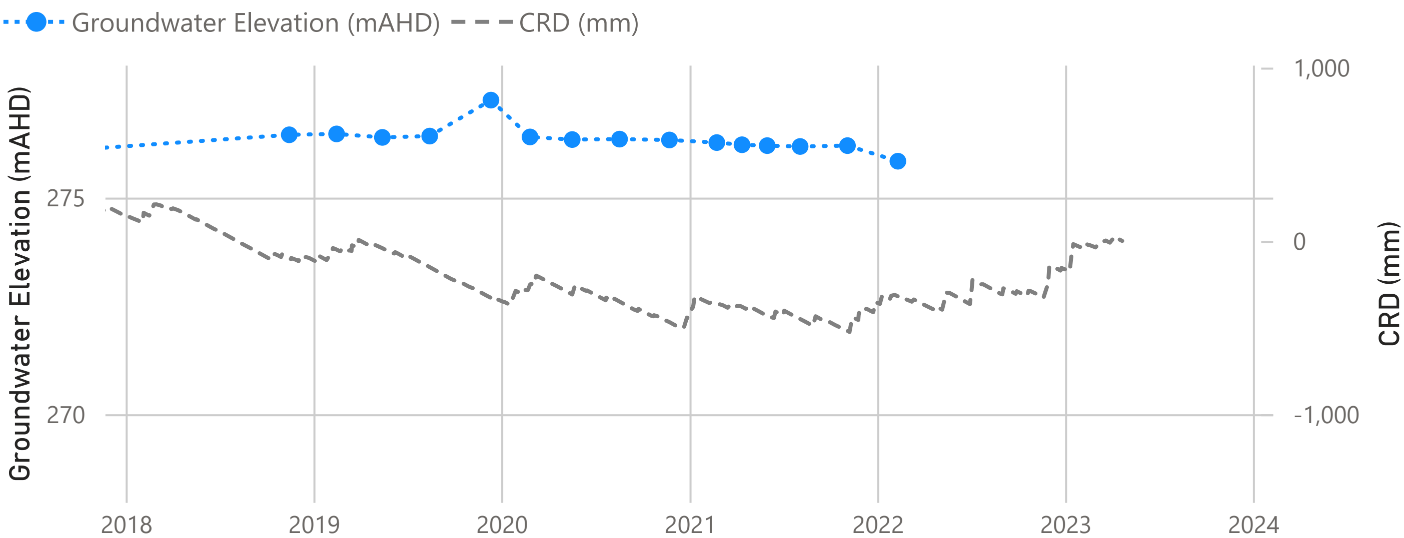
Rangal Coal Measures

PT1

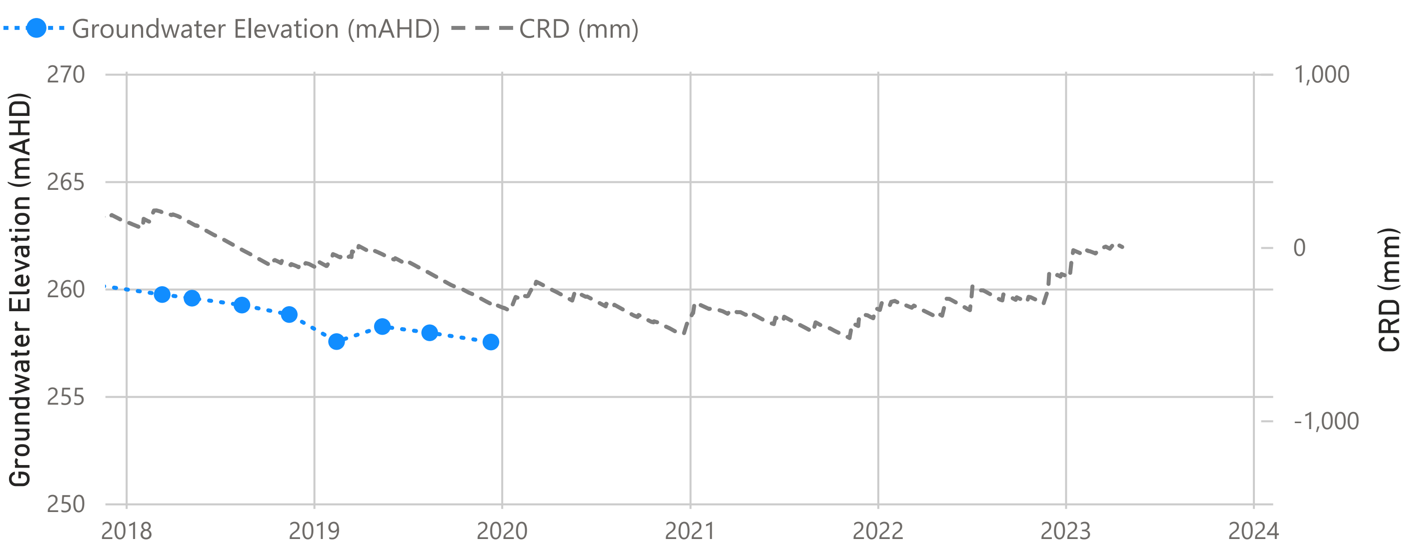


Rangal Coal Measures

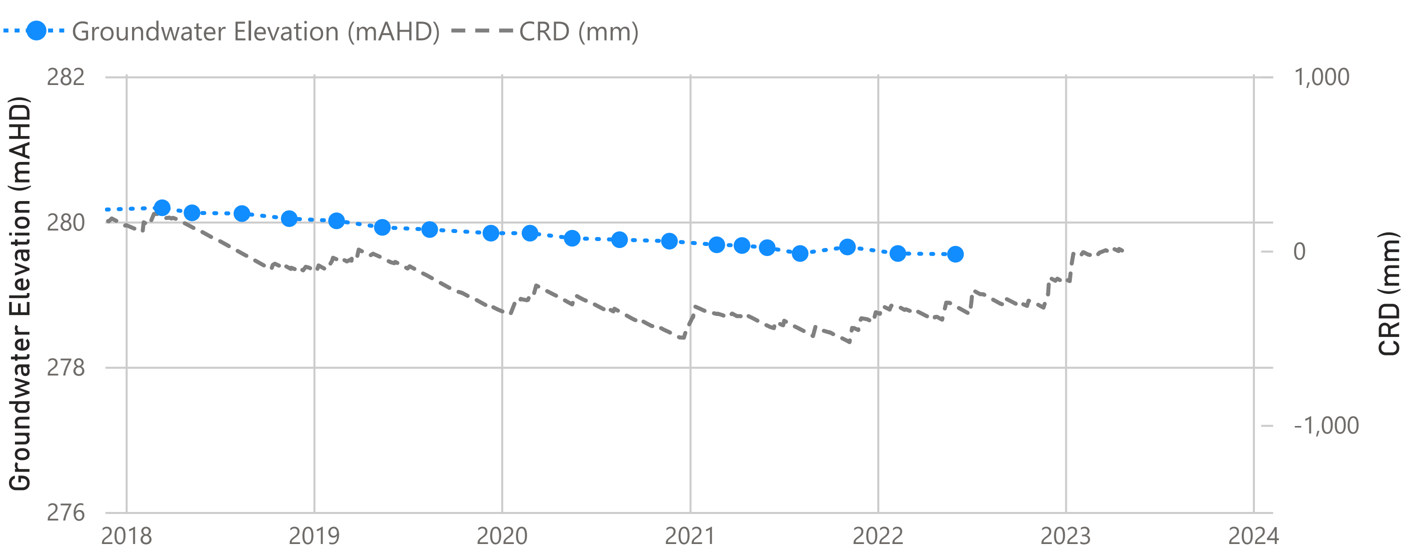
BDW172_(54)



BDW366P

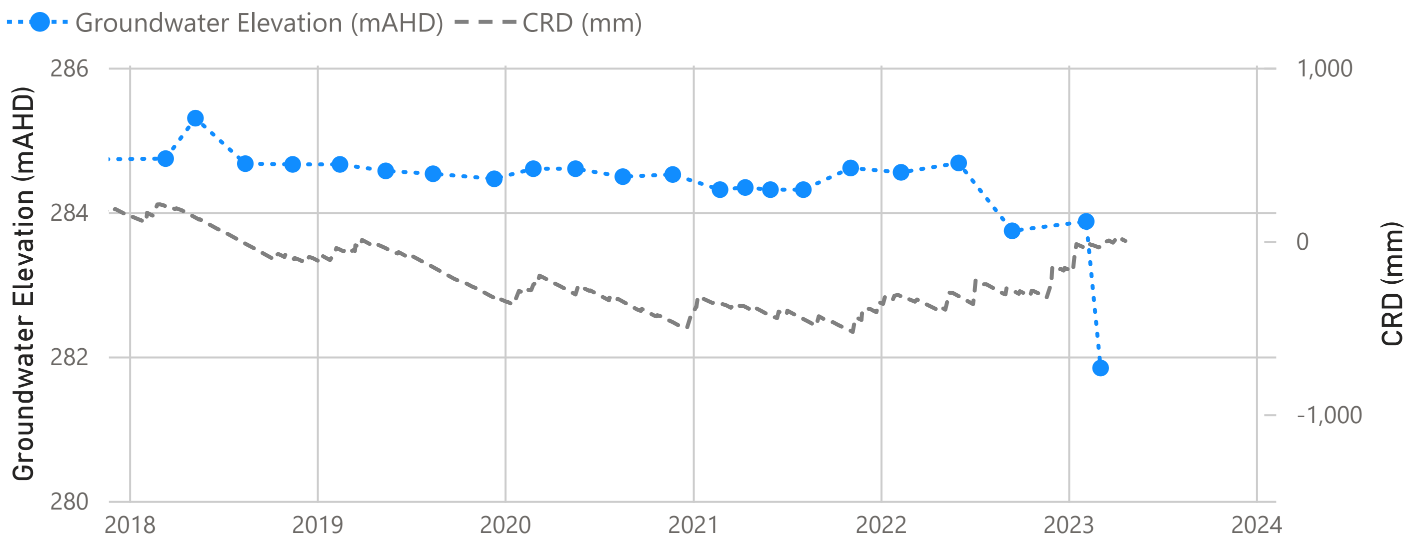


BDW5C

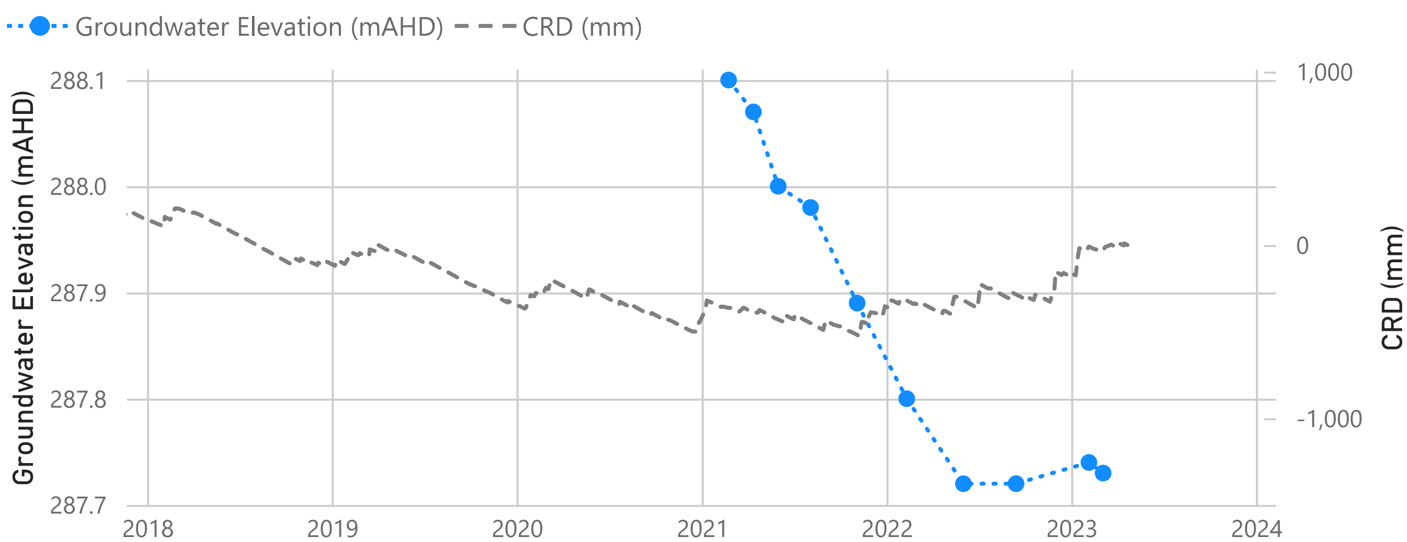


Rangal Coal Measures

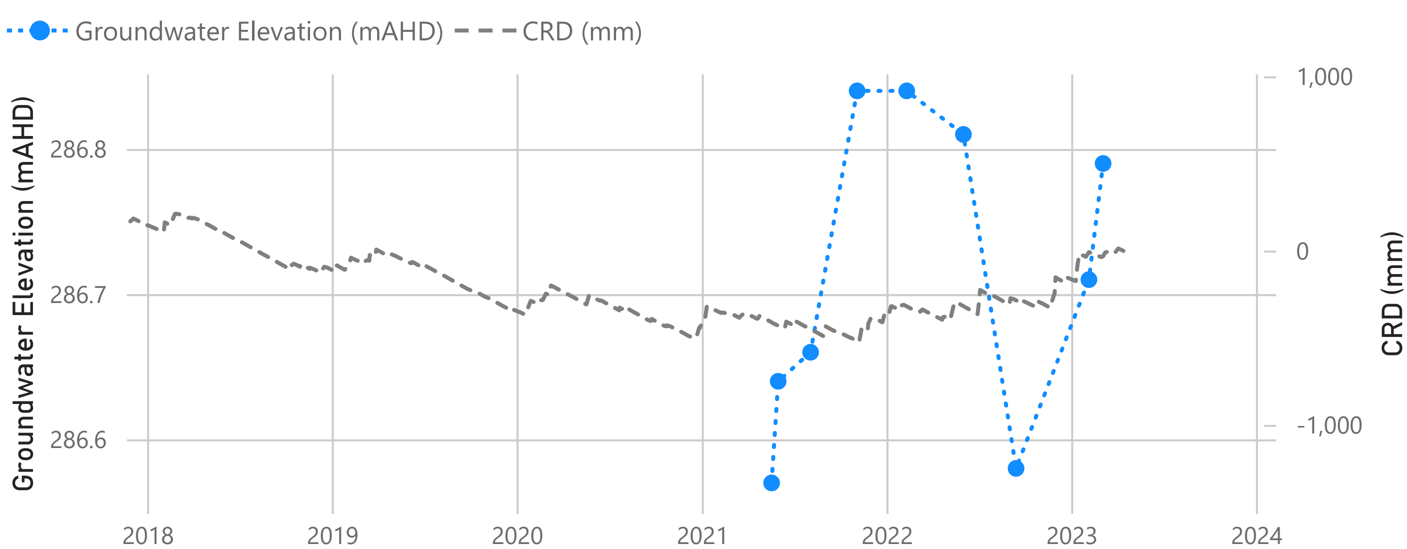
BDW8C



MBBE0001



MBBE0008



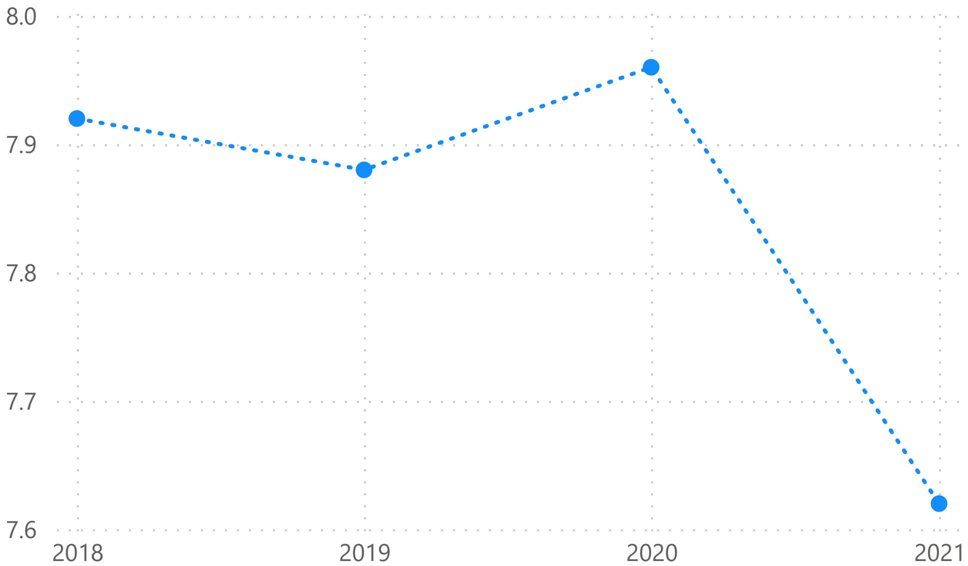
APPENDIX III

Groundwater Chemistry Graphs

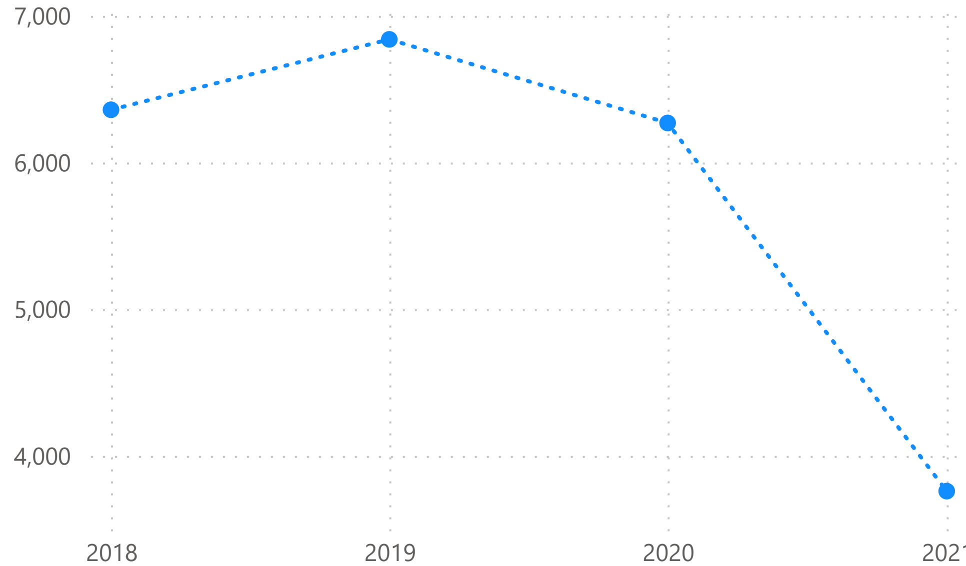
Alluvium

● EFGW1S

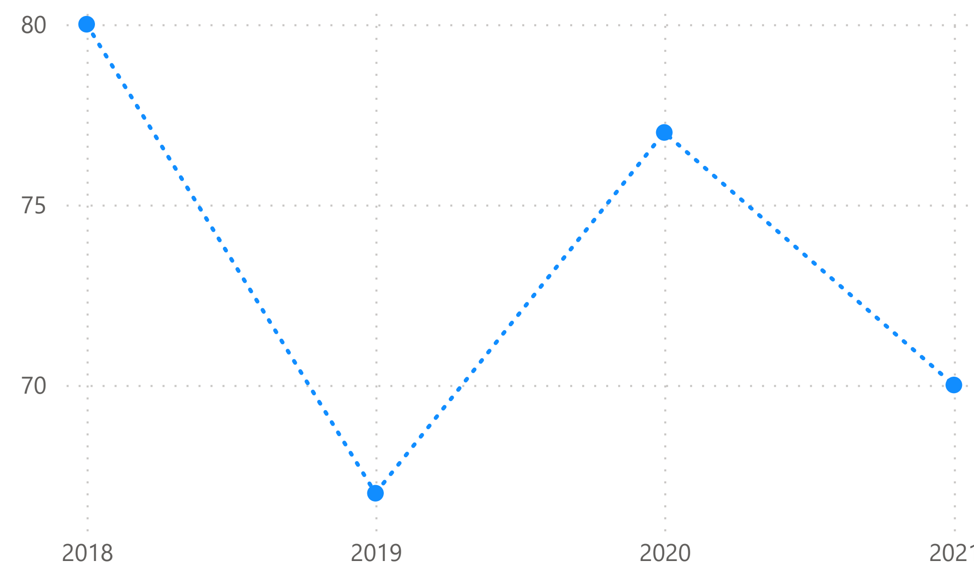
pH (pH unit)



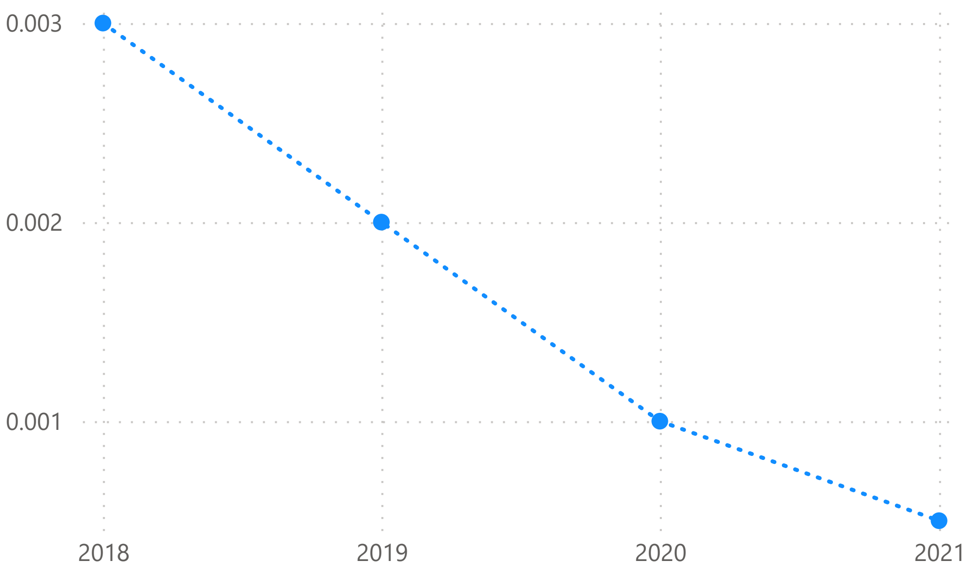
EC (uS/cm)



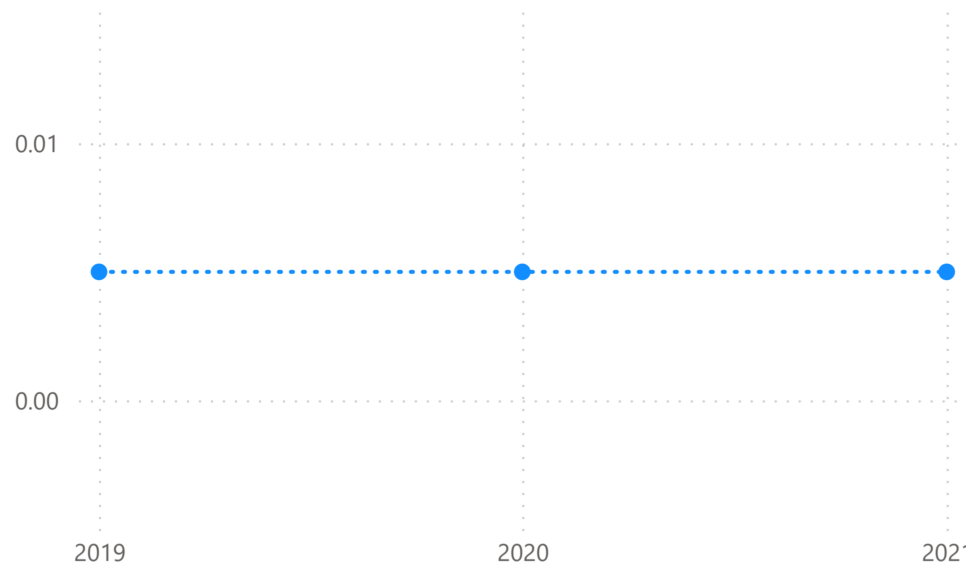
Sulfate (mg/L)



Dissolved Arsenic (mg/L)



Dissolved Aluminium (mg/L)



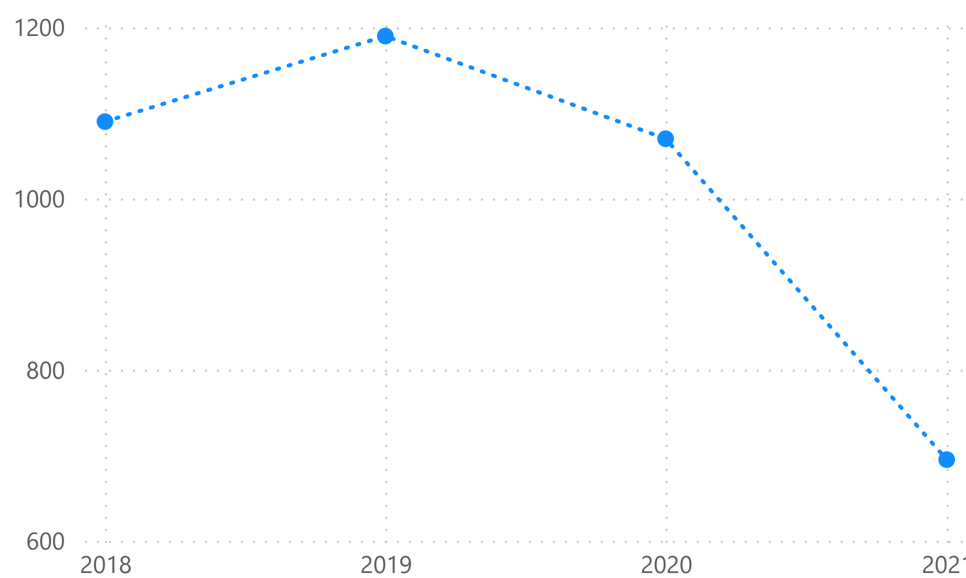
Dissolved Molybdenum (mg/L)

No Dissolved Molybdenum data for EFGW1S

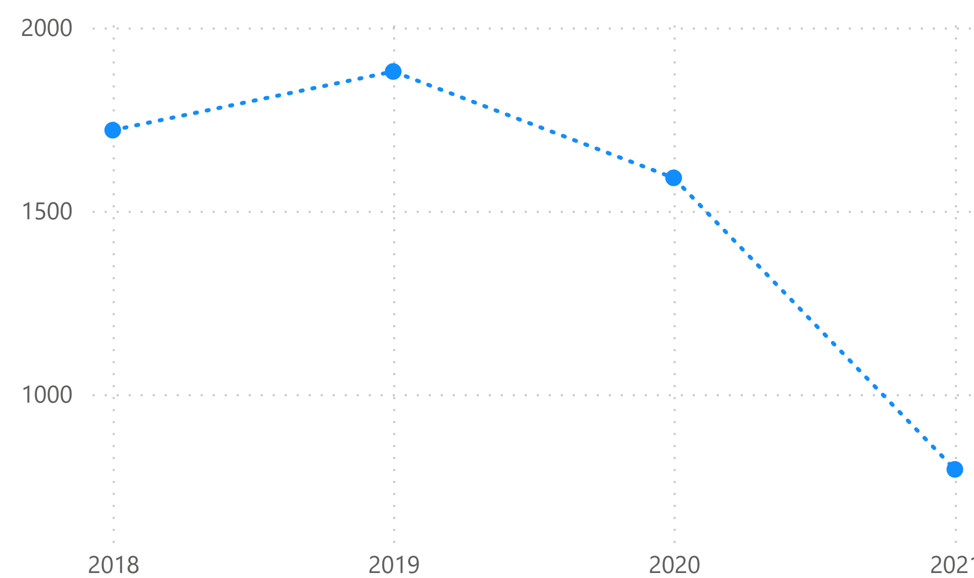
Dissolved Selenium (mg/L)

No Dissolved Selenium data for EFGW1S

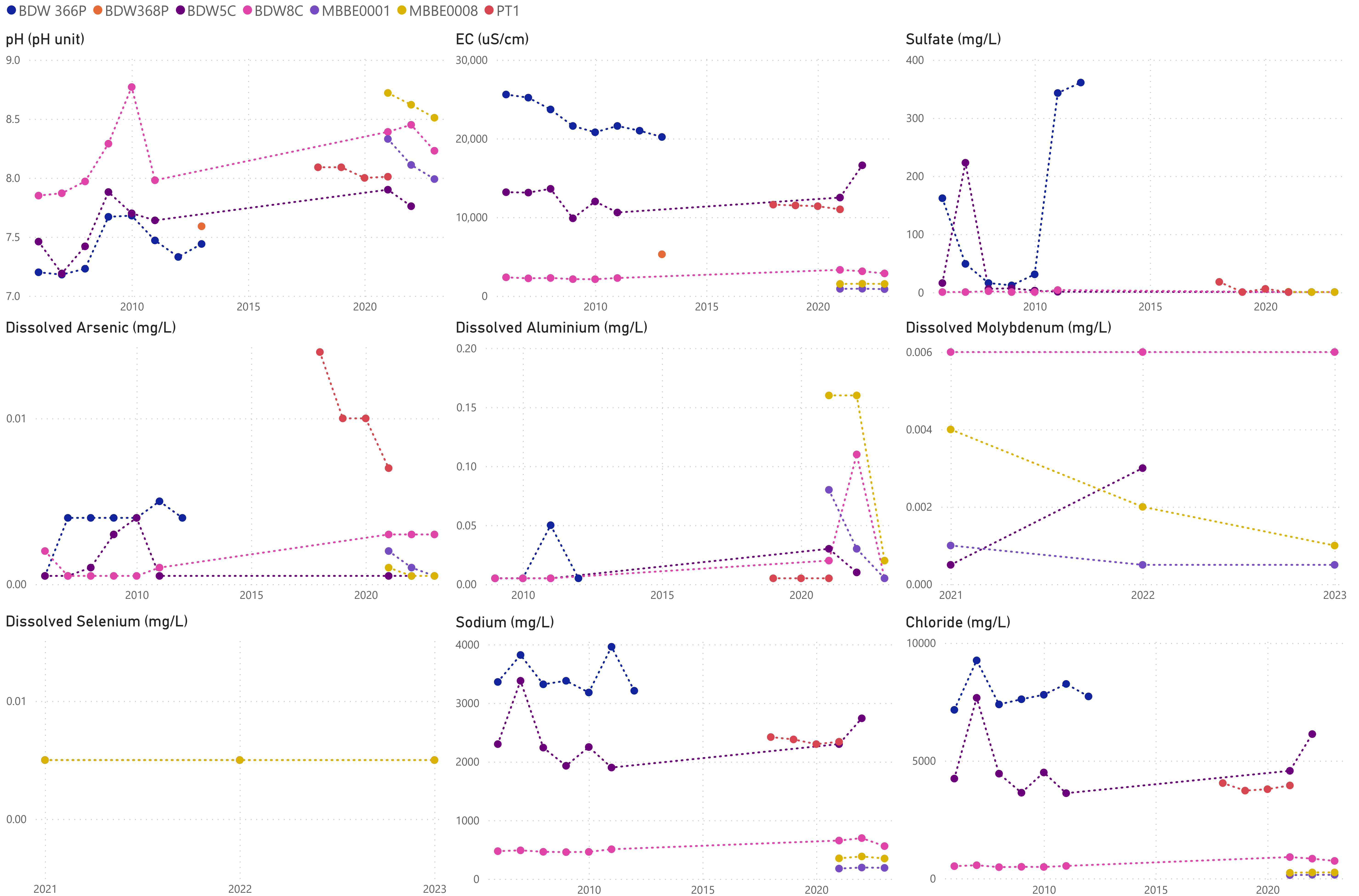
Sodium (mg/L)



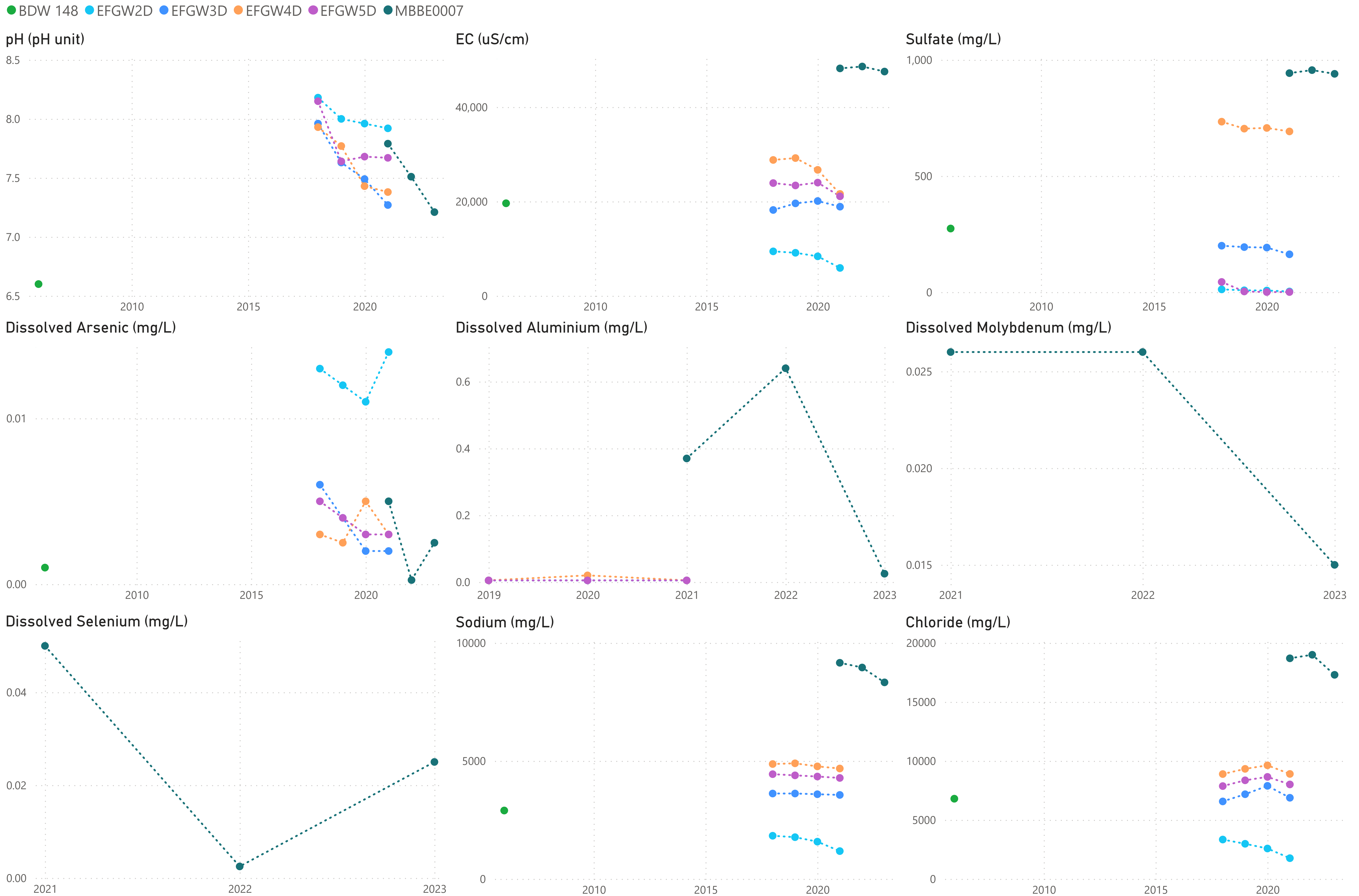
Chloride (mg/L)



Rangal Coal Measures



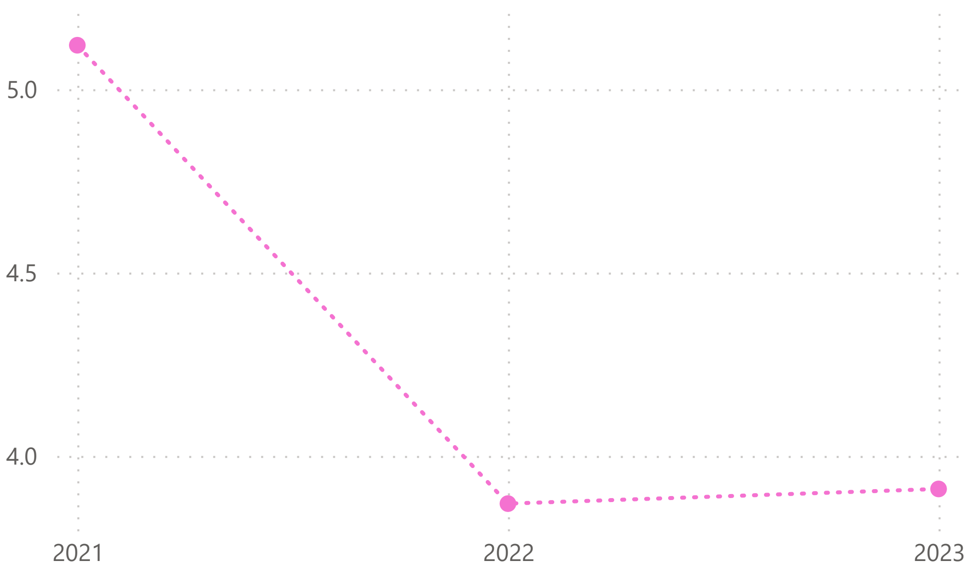
Rewan Group


BDW 148 EFGW2D EFGW3D EFGW4D EFGW5D MBBE0007
pH (pH unit)
8.5
8.0
7.5
7.0
6.5
2010
2015
2020
EC (uS/cm)
40,000
20,000
0
2010
2015
2020
Sulfate (mg/L)
1,000
500
0
2010
2015
2020
Dissolved Arsenic (mg/L)
0.01
0.00
2010
2015
2020
Dissolved Aluminium (mg/L)
0.6
0.4
0.2
0.0
2019
2020
2021
2022
2023
Dissolved Molybdenum (mg/L)
0.025
0.020
0.015
2021
2022
2023
Dissolved Selenium (mg/L)
0.04
0.02
0.00
2021
2022
2023
Sodium (mg/L)
10000
5000
0
2010
2015
2020
Chloride (mg/L)
20000
15000
10000
5000
0
2010
2015
2020

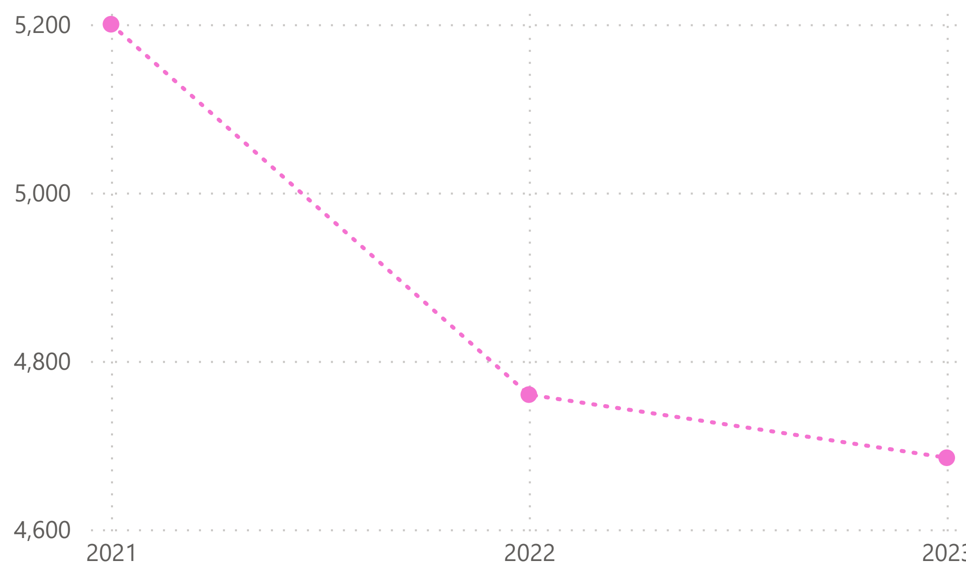
Tertiary Sediments

MBBE0002

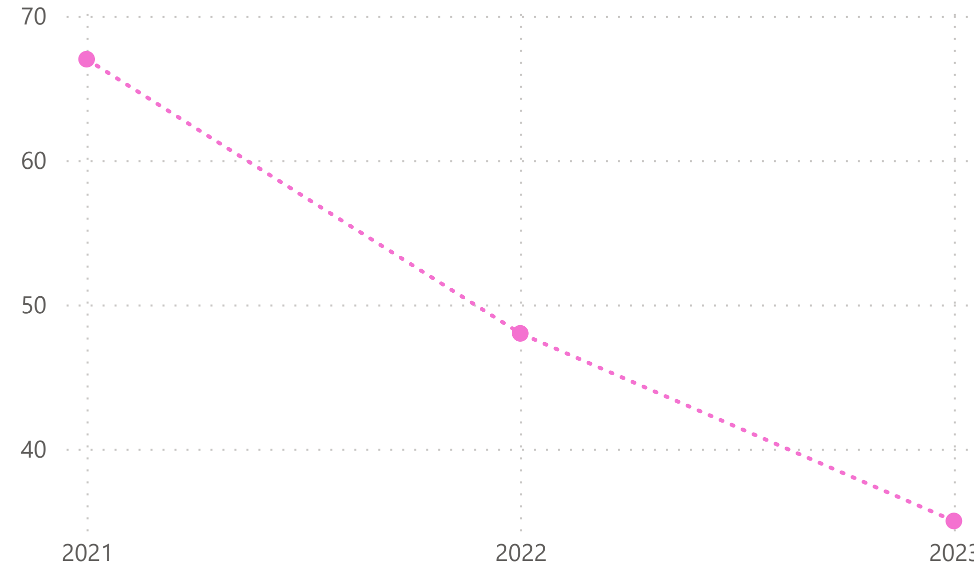
pH (pH unit)



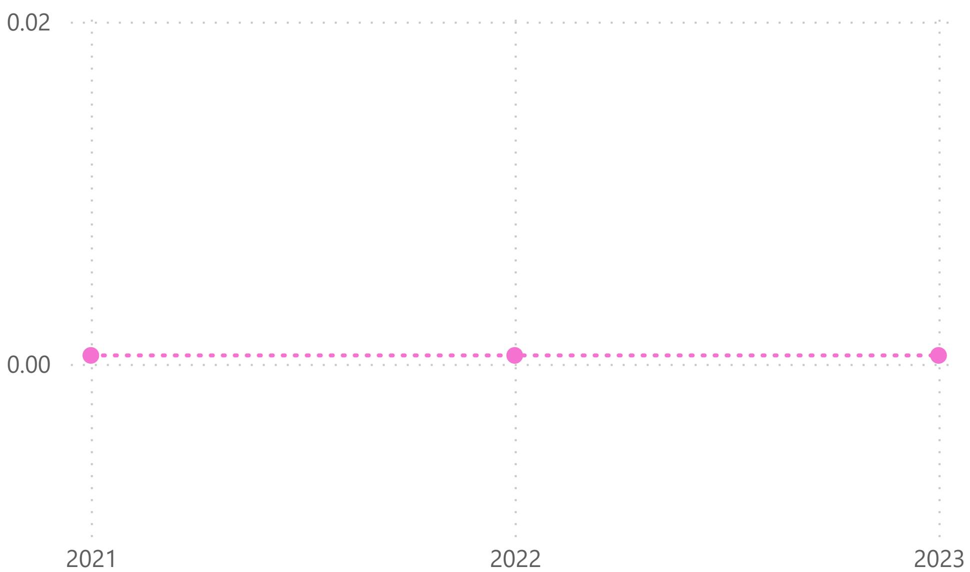
EC (uS/cm)



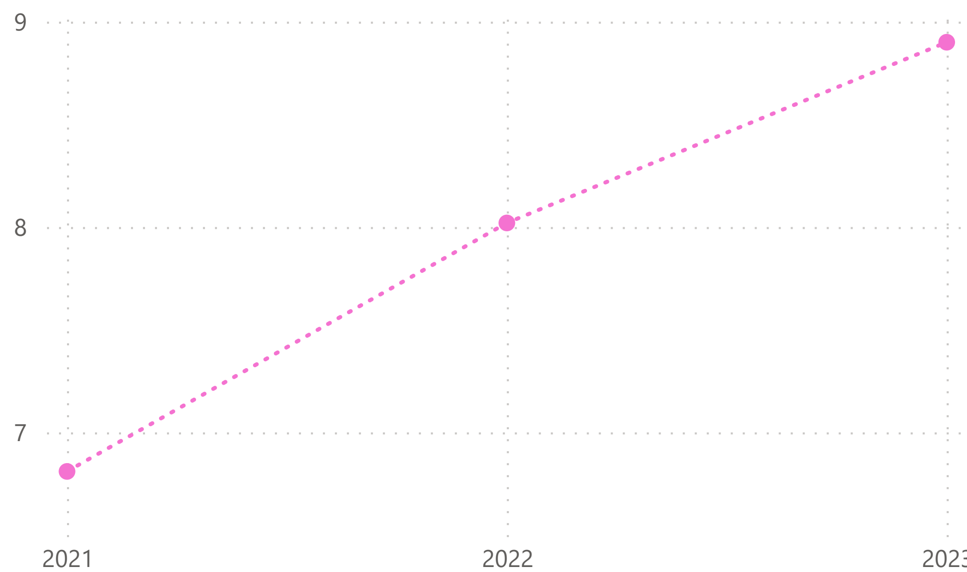
Sulfate (mg/L)



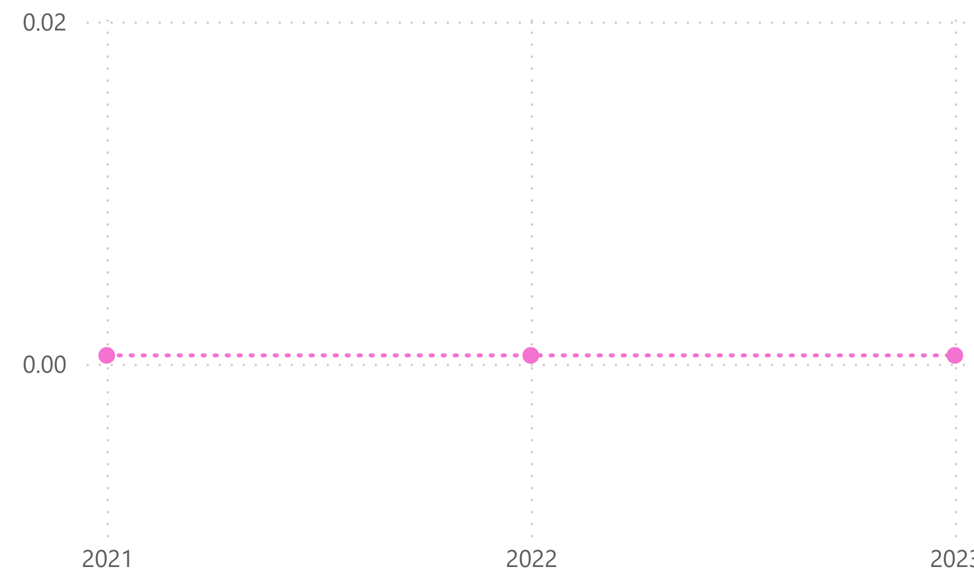
Dissolved Arsenic (mg/L)



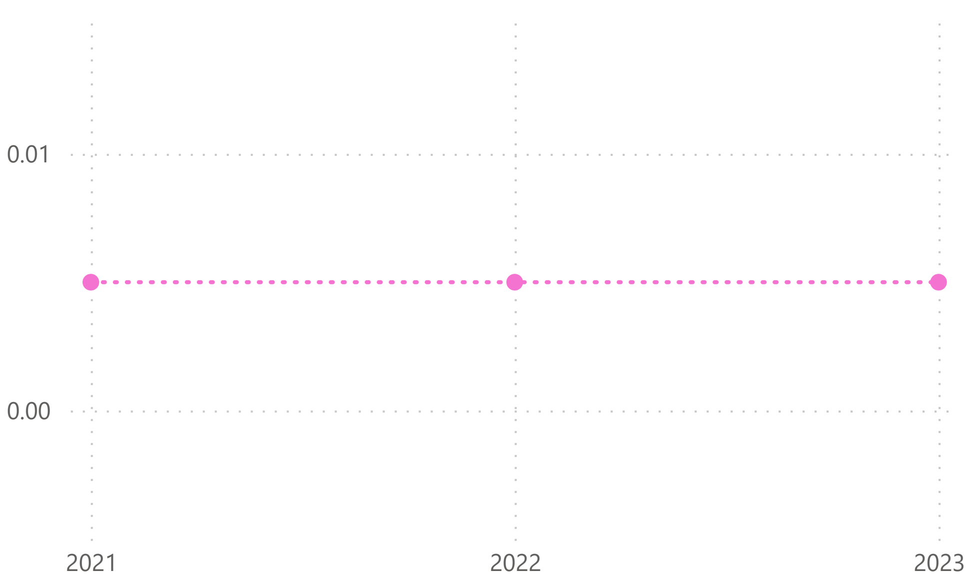
Dissolved Aluminium (mg/L)



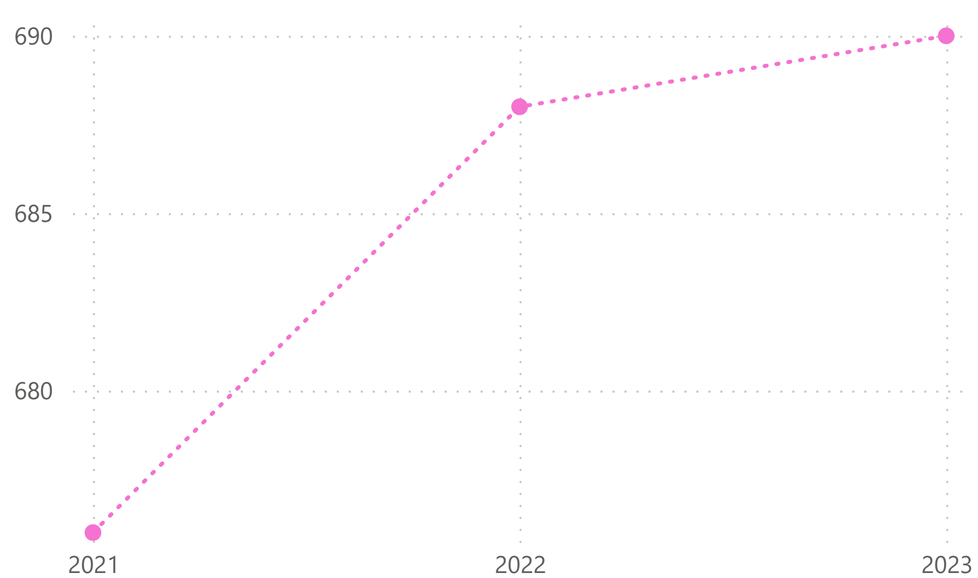
Dissolved Molybdenum (mg/L)



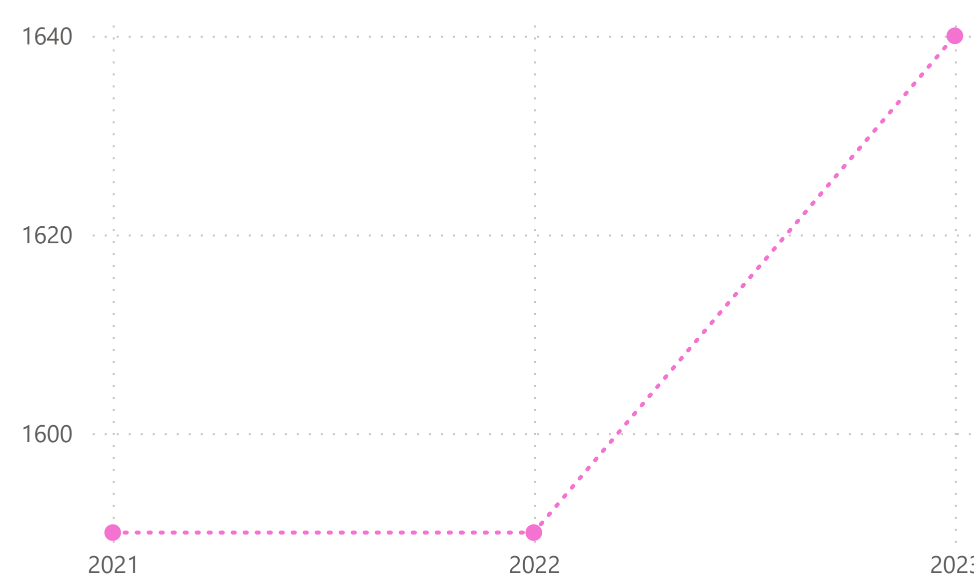
Dissolved Selenium (mg/L)



Sodium (mg/L)



Chloride (mg/L)



APPENDIX IV

Numerical Groundwater Modelling

Appendix IV
Numerical Groundwater Modelling

IV-1 MODEL OBJECTIVES

A numerical groundwater model has been constructed to support the BME Progressive Rehabilitation and Closure Plan (PRCP) to predict changes in groundwater levels and flow during operations and into closure. The objectives of the model include:

- Estimating groundwater inflow / outflow in the final voids; and
- Predicting the extent and area of influence of groundwater level drawdown associated with the final voids.

The numerical groundwater model has been constructed and simulated with consideration of the Australian Groundwater Modelling Guidelines (Barnett et al. 2012) and the requirements of the PRCP Guideline (DES 2021).

IV-2 MODEL HISTORY

This groundwater model was initially developed for the Broadmeadows East Groundwater Impact Assessment (KCB 2021). The model was developed to simulate the existing conditions of the groundwater regime and provide predictions of the potential impacts of the proposed mining activities. The model was updated for the PRCP project through:

- Recalibration of the model to include the most recent groundwater monitoring data;
- Incorporation of the most recent operational plan; and
- Incorporation of the post-closure landform.

IV-3 MODEL CONSTRUCTION

IV-3.1 Model Code

The water-bearing formations within the Project area are complex systems. Due to the processes that formed the upper Tertiary units, along with the folding nature of the pre-Tertiary sediments, and the influence of the regional thrust fault all modelled units (with the exception of the bottom model layer) are discontinuous across the model domain. This is a challenge to reproduce using modelling platforms that are based on regular grid arrangements, as all layers are required to be laterally extensive across the model domain.

MODFLOW-USG is an “unstructured grid” version of MODFLOW that has the capabilities to use an irregular grid structure with arbitrary cell/node connections. This enables focused grid refinement to occur in areas where detail is important, without the need for continuation of grid refinement to the extents of the model domain. It also facilitates implementation of pinching-out layers and/or layer discontinuities within the modelled domain. In complex models, this can greatly reduce the number of grid cells within the model domain and thus greatly reduce model runtimes. In addition, MODFLOW-USG implements an “upstream weighting” formulation of the groundwater flow equation that allows cells to dewater and re-saturate with relative impunity, ideal for simulating mining activities where dewatering and groundwater recovery is prominent. For these reasons, MODFLOW-USG was selected for this assessment.

IV-3.2 Model Domain and Hydrogeological Study Area

Figure IV-3.1 and Figure IV-3.2 presents the spatial extents of the groundwater flow model domain and covers ~280km^2. The model domain was selected to reflect the regional hydrostratigraphic units while also considering there is sufficient lateral extent to include relevant historical, existing and approved future (if present) mining operations in the region. In setting the model domain, the potential extent of Project groundwater impacts was also considered. In detail, this included:

- The established model domain boundaries are primarily defined by topography and hence coincides locally with groundwater divide conditions; which represents the northeast, northwest and southeast boundaries. The model domain also encompasses the mining activities in the vicinity of Project area.
- The southwestern boundary of the model domain is located at a distance from the Project area such that drawdown impacts resulting from the proposed mining activities are not interpreted to extend to the boundary.

IV-3.3 Application of Conceptual Model

The development of the groundwater flow model was based on the conceptualisation of the hydrogeological system. This conceptualisation is described in the main PRCP report. The hydrogeological conceptualisation is a descriptive representation of the groundwater flow system and stresses. The closer the numerical model represents the conceptual understanding, and the site conditions, the better the performance of the model in making predictions (Anderson and Woessner 1992). The conceptual understanding defines the key processes of the groundwater system with consideration to the influence of stresses (Barnett et al. 2012)

The application of the conceptual understanding to the groundwater flow model required synthesis and description of the geological framework and consideration of the groundwater flow systems at and in the vicinity of the Project area.

A thrust fault to the west of the Project area has upthrown and subsequently eroded the overlying Triassic strata to expose the Rangal Coal Measures. The position of the thrust fault defines the location of significant hydrostratigraphic unit displacement and has been represented by model layer elevations and hydraulic property changes. In this conceptual setting the fault restricts groundwater flow as a flow barrier in the horizontal direction.

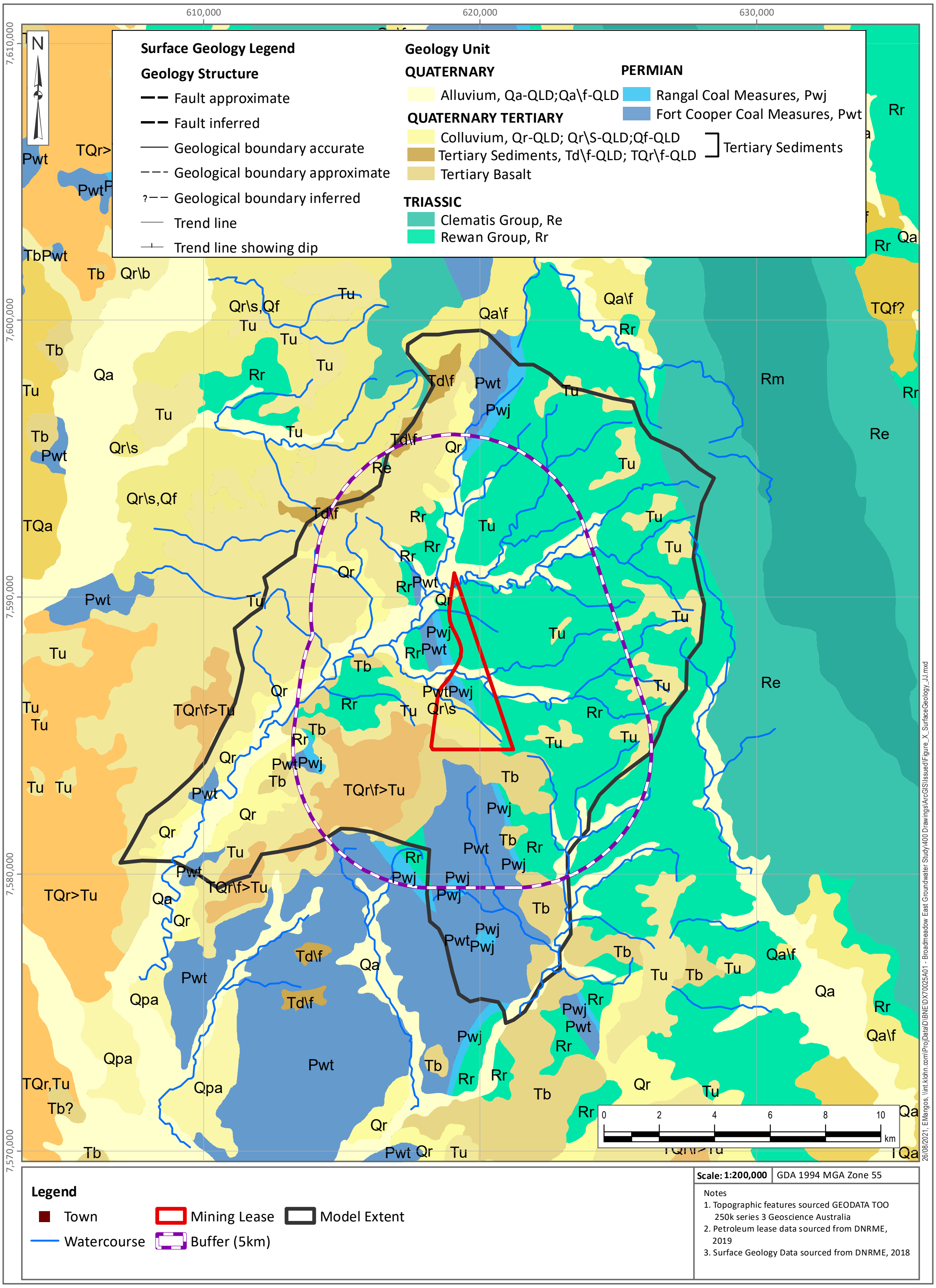


Figure IV-3.1 Surface Geology with Numerical Groundwater Model Extent

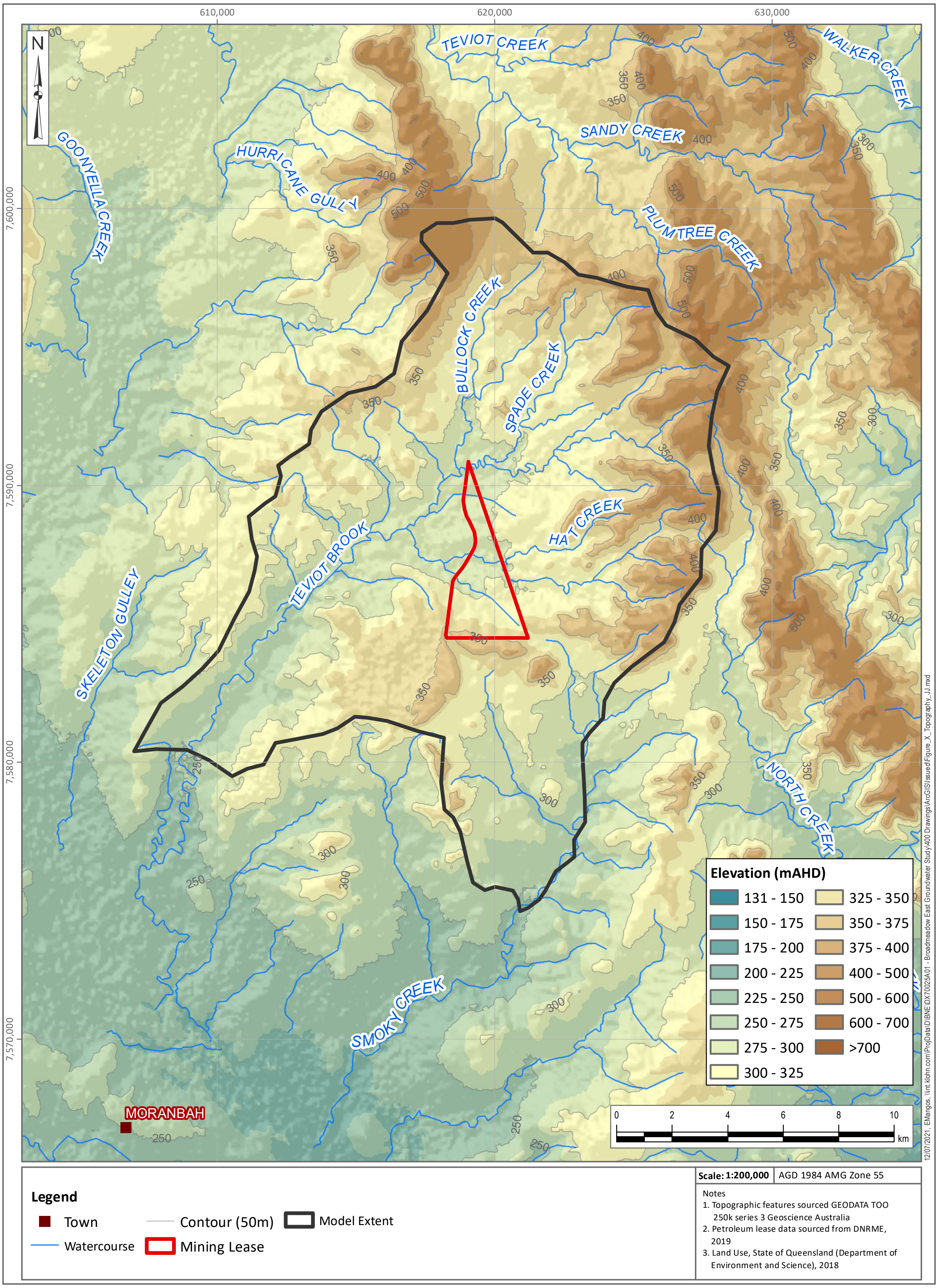


Figure IV-3.2 Surface Topography with Numerical Groundwater Model Extent

IV-3.4 Model Processing and Discretisation

Algomesh was used to develop an unstructured grid based on Voronoi polygons and to calculate cell connectivity along with geometries of connected cell interfaces necessary for execution of the MODLOW-USG model. Grid mesh refinement was focused on the extent of the Quaternary alluvium, major surface water drainage lines, major structures and the proposed mine development areas. The key hydrostratigraphic units were refined with average mesh size ranges from 300 to 350 m, and the minimum allowable internal angle in any single cell was set to 30 degrees. The mining area was discretised into fine rectangular meshes with orientations in line with the mining schedule. The minimum cell thickness was set at 0.2 m, and as a result, Algomesh pinched-out all cells that have a thickness of <0.2 m.

The resulting grid cell mesh developed from these settings is shown in Figure IV-3.3 and Figure IV-3.4. Six model layers were used to represent the hydrostratigraphic units underlying the Project area; these are discussed further in the following section. The final model grid comprises 45,733 active cells.

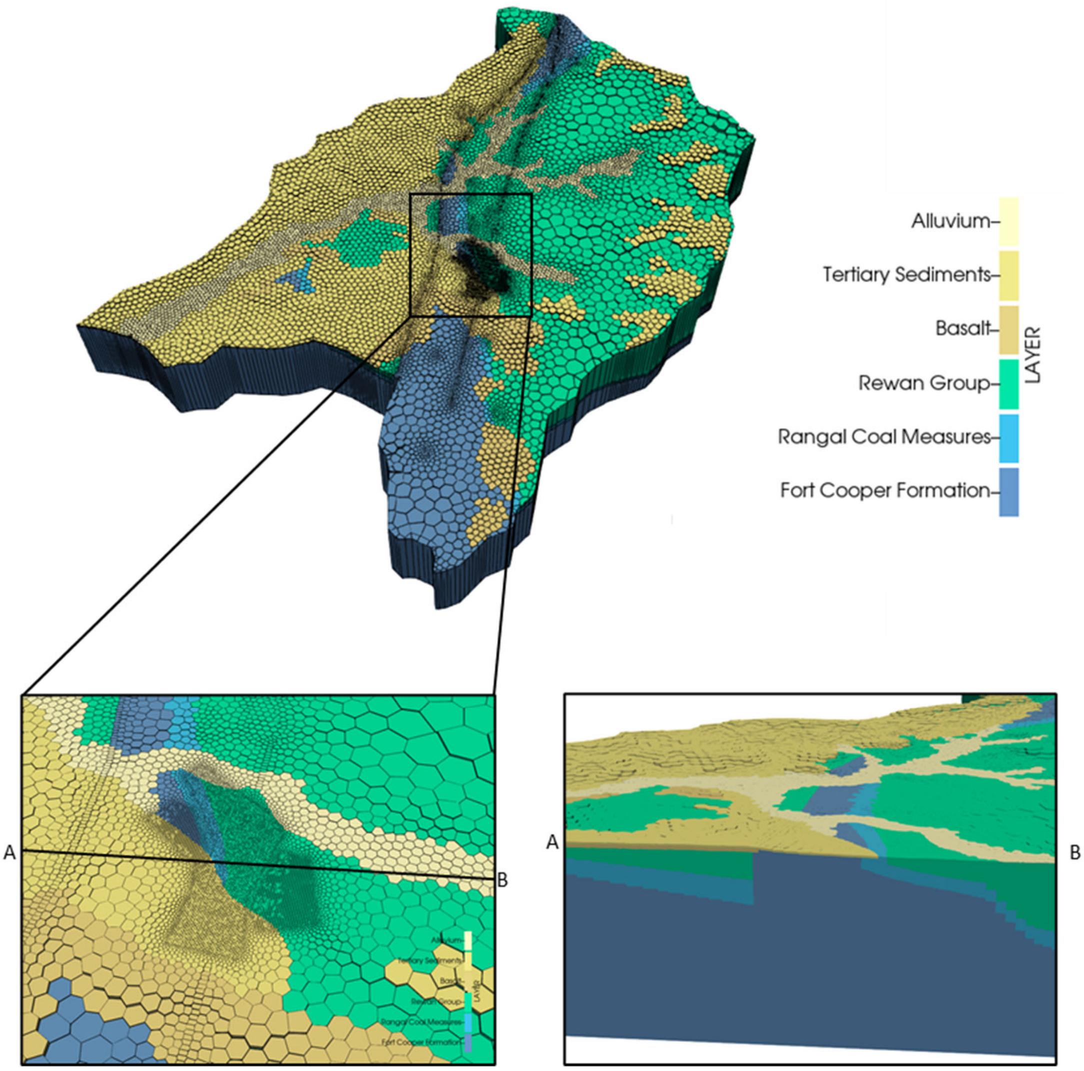


Figure IV-3.3 3D Diagram of Groundwater Model Geometry (Vertical Exaggeration = 2x)

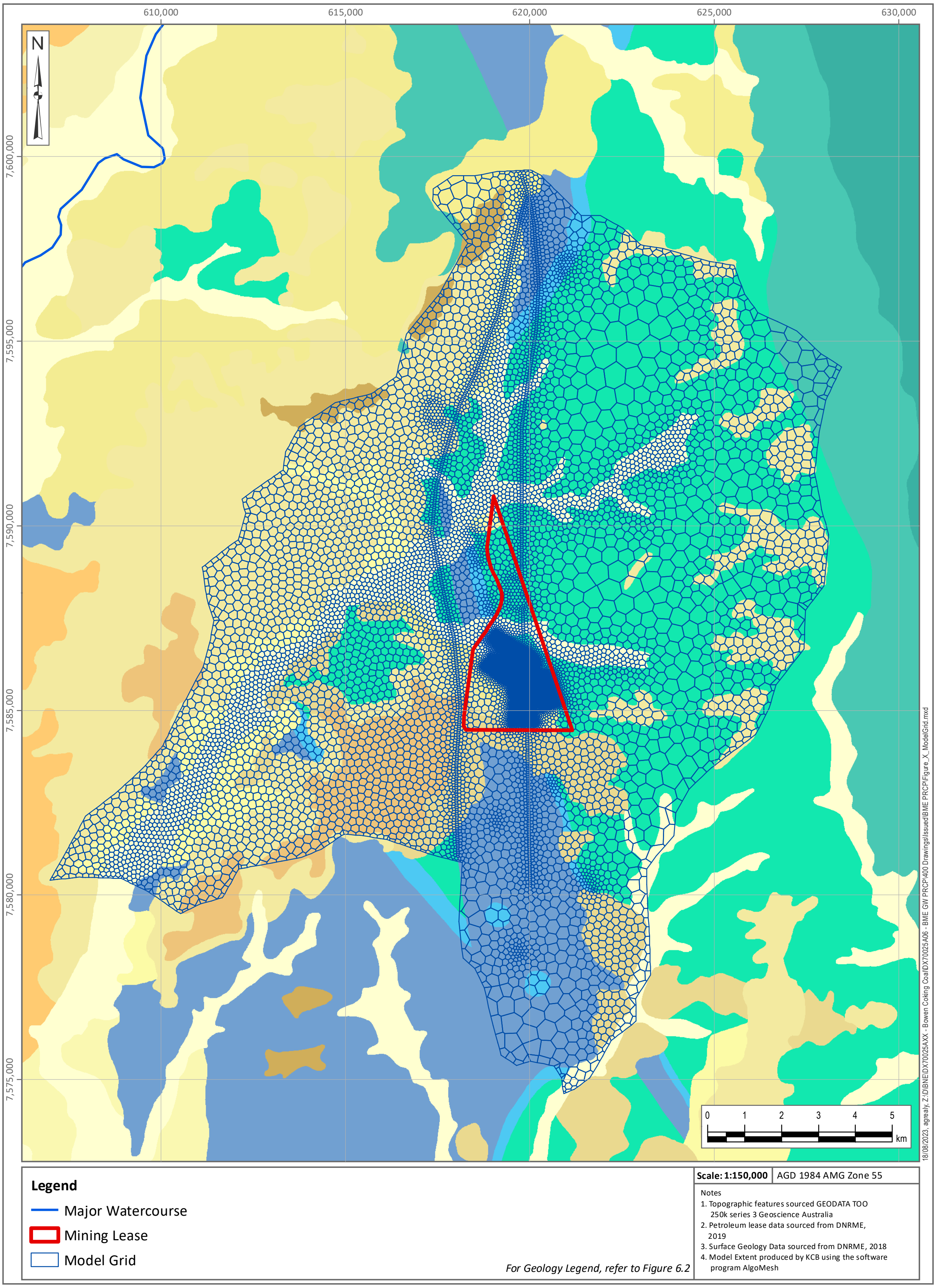


Figure IV-3.4 Groundwater Model Domain and Grid Mesh

IV-3.5 Units and Datum

The time unit for the model is days and the length unit is metres. In the horizontal plane the model uses the AMG84 Zone 55 projection, while the vertical datum is the Australian Height Datum (AHD) in metres.

IV-3.6 Model Layers

The hydrostratigraphy of the Project area is represented by six (6) layers, which are predominantly discontinuous across the model domain. Table IV-3.1 and Figure IV-3.5 present the model layers and the primary geological units that are represented by each.

Table IV-3.1 Summary of Model Layers

Model Layer	Hydrogeological Unit	Geological Age
1	Alluvium	Quaternary
2	Tertiary Sediments	Tertiary
3	Basalt	
4	Rewan Group	Triassic
5	Rangal Coal Measures	Permian
6	Fort Cooper Coal Measures	

The surfaces that were used to develop the above layers are derived from the following:

1. Surfaces and isopachs provided by Zenith and RPM Golbal (formerly NitroSolutions).
2. Borehole logs from Geological Survey of Queensland drilled investigation holes.
3. Publicly available CSG drilling logs accessed from the QDEX database.
4. Surfaces and data from the Bowen Basin Supermodel 2000.
5. Outcrop locations of surface geology mapping.

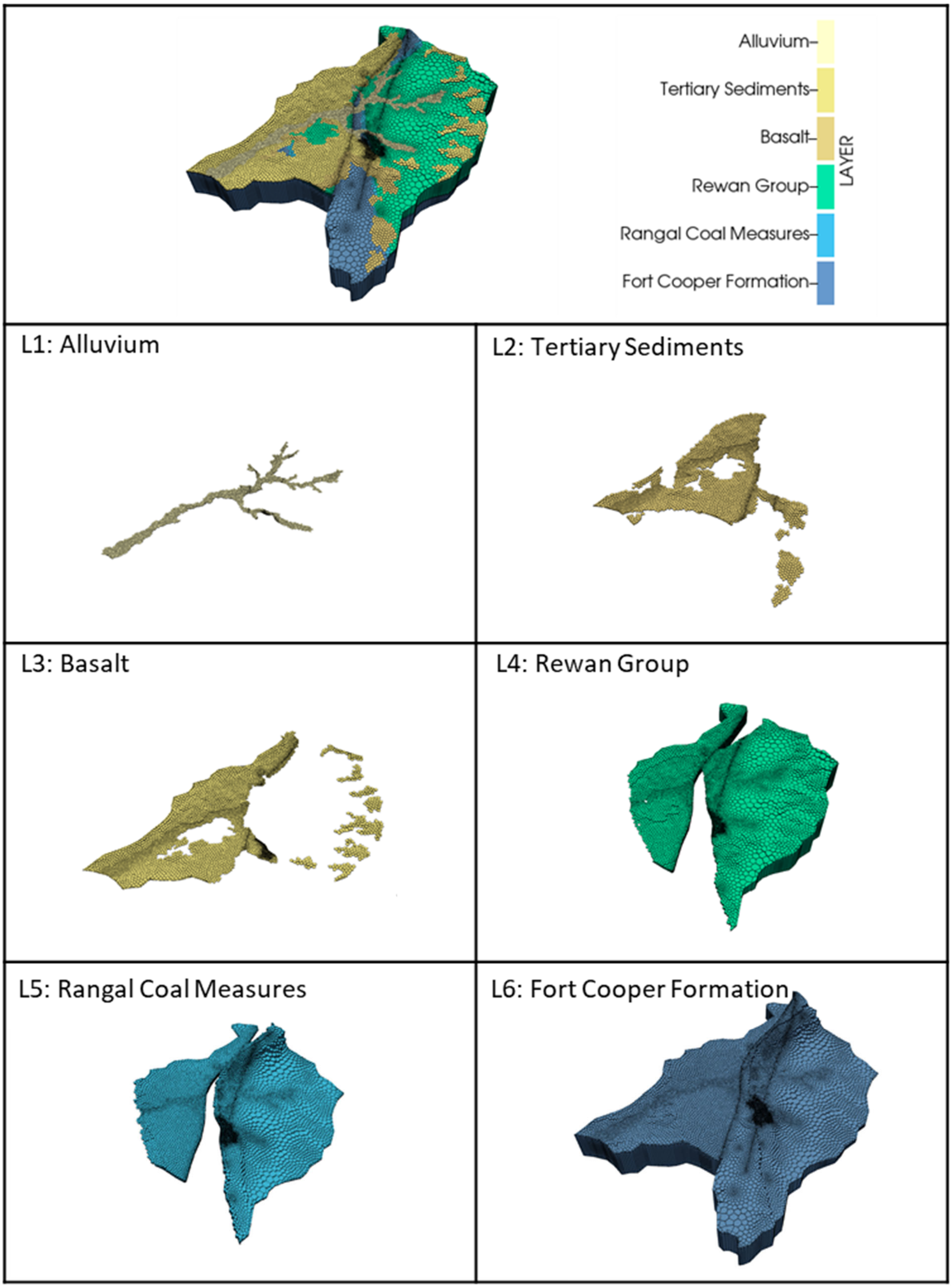


Figure IV-3.5 Layer Extents and Morphology in the Numerical Groundwater Model

IV-3.7 Model Boundary Conditions

Boundary conditions are necessary for the solution of the 3D groundwater flow equation that is implemented by MODFLOW-USG. These boundary conditions establish the groundwater fluxes, levels/pressures and stresses within the model.

The following boundary conditions have been adopted in the BME model:

Recharge

Groundwater recharge was applied in zones (Figure IV-3.6) based on the extents of outcropping geological units, using the RCH package of MODFLOW. The four recharge zones defined for this model are the extents/outcrop of: Quaternary alluvium, Tertiary sediments, Tertiary basalt, and Permian units.

Recharge rates for the model have been calculated as a percentage of historically recorded quarterly rainfall totals. The percentage of rainfall that enters the model as recharge in each zone was adjusted during calibration.

Evapotranspiration

Evapotranspiration is a boundary component of the water budget for the groundwater system. In this model, it has been implemented using the MODFLOW EVT package. A uniform extinction depth has been applied across the domain and set at 1.5 m below the natural surface, below which evaporative losses from the groundwater surface are zero. Where the groundwater elevation is above this level, water is removed from the system at a maximum rate of 1,200 mm/annum. This value is adopted from the average areal potential evapotranspiration map (BOM 2008); which is based on a standard 30-year climatology from 1961-1990.

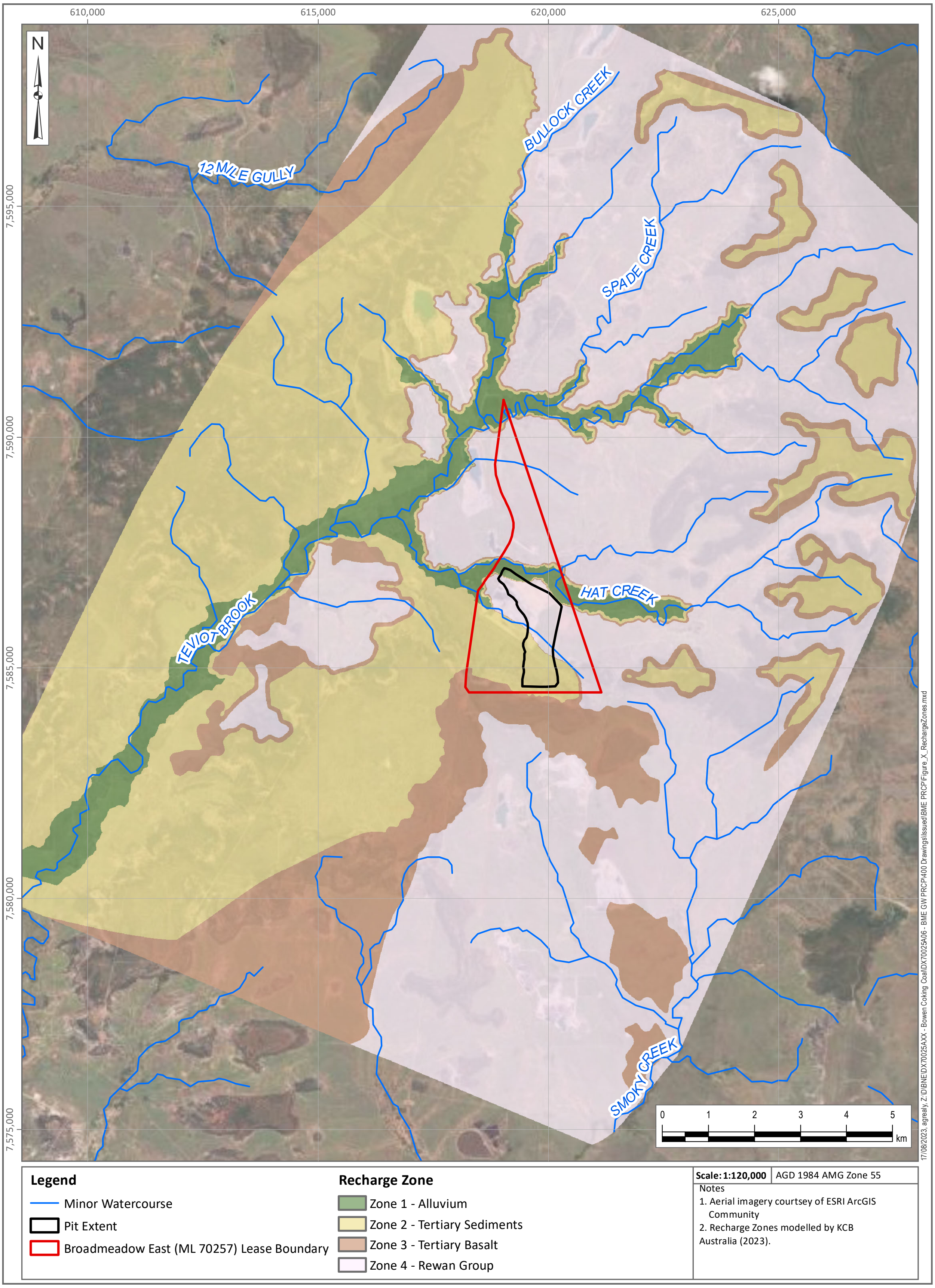


Figure IV-3.6 Recharge Zones

Drains

Drains cells have been used to simulate open cut activities across the model domain with the application of the MODFLOW Drains package (DRN). In the Project area, drains are placed in all layers above and including the target coal seam layer, in accordance with the mining schedule. Reference drain elevations were specified in accordance with this schedule, while conductance values for these drain cells were set nominally high values of more than 10 m^2/day.

The major water courses in the model domain are also represented using the drain cells. The surface drainage system of the area is ephemeral in nature, and when stream flows do happen, they are usually rapid and persist for short periods of time. In these drain cells the reference head was specified as the model top, and a conductance was calculated to be consistent with the hydraulic conductivity and dimensions of the cell in which they are placed.

A “no flow” boundary condition was applied to the base of the model located below the Fort Cooper Coal Measures. This boundary is located at a significant depth below the Project mining area and has no material influence on the model results.

General Head

General Head Boundary (GHB) cells (GHB package) were assigned around the active perimeter of the model domain and are applied to all layers of the model. Use of this boundary type allows for the representation of the regional groundwater flow. Conductance values applied to the GHB cells were calculated to be consistent with hydraulic conductivity values for each hydrostratigraphic unit and the dimensions of the boundary cells. A reference head for these cells was obtained from steady-state model heads in a pre-development scenario. This boundary is sufficiently distant from the Project area so as not to materially influence model prediction performance.

IV-3.8 Application of Hydraulic Parameters

Hydraulic properties for the model layers, corresponding to the various hydrostratigraphic units have been applied under the assumption of homogeneity across the model domain. Vertical hydraulic conductivity in all layers is calibrated as a factor of the horizontal hydraulic conductivity.

IV-3.9 Calibration Process and Metrics

Model calibration was performed based on the adjustment of model parameter values to allow better replication of historical observations of the system. The outcome of the calibration process also provides the initial conditions for transient predictive simulations used to assess changes to the groundwater regime through operations and closure.

The transient period used for model calibration consists of quarterly stress periods over the duration March 2019 to January 2023. This was preceded by a steady-state stress period to condition the model prior to the transient calibration. A quarterly stress period sequence was adopted for the predictive model runs.

IV-3.9.1 Calibration Approach

The Project area is located in a part of the Bowen Basin that is heavily exploited and comprises numerous mining operations that have previously been in operation. As a result, groundwater levels from monitoring bores adjacent to historical operations reflect the impacts of these mining activities (e.g. drawdown due to dewatering, recovery at the cessation of mining operations). Without an understanding of the historical mining activities and associated schedules, it is difficult to match modelled results with certain monitoring bores as part of the calibration process. Therefore, a review of the available monitoring bore network was undertaken to identify monitoring bores, and associated groundwater level records, that could be incorporated into the calibration process. Calibration focused on the more recent system conditions over the period March 2019 to January 2023.

The calibration model run was initiated as a steady-state simulation with boundary conditions applied to replicate known mining development before March 2019. After this initial model conditioning period, the model then progresses to transient mode for the aforementioned calibration period, during which quarterly stress periods are then implemented. This stress period interval readily accommodates the variations in rainfall records. All observations used as calibration targets pertain to the transient component of the simulation. A total of 28 adjustable parameters were used, and include hydraulic conductivities, storage properties and recharge factors.

IV-3.9.2 Calibration Targets

The calibration dataset comprised groundwater level measurements. These measurements were compiled from 18 monitoring bores for which reliable water level measurements were available over the transient calibration simulation period. In total, 192 individual measurements from monitoring bores were used in the calibration process. A number of monitoring bores installed across the Project area in the upper hydrostratigraphic units (e.g. Quaternary alluvium, Tertiary sediments, Tertiary basalt) are dry, indicating unsaturated conditions, and resulting in no groundwater level records. Despite the lack of groundwater level records from the upper hydrostratigraphic units, this unsaturated characteristic also provided a calibration criteria for the model.

Figure IV-3.7 presents a comparison between groundwater level measurements and the calibrated model output equivalents. A residual plot map is shown in Figure IV-3.7 and displays the distribution of the residual values across the area. During calibration, all measurements of the calibration dataset were given equal weight, resulting in the extraction of maximum information from the calibration dataset during estimation of parameters.

Figure IV-3.7 Calibration Residuals Results

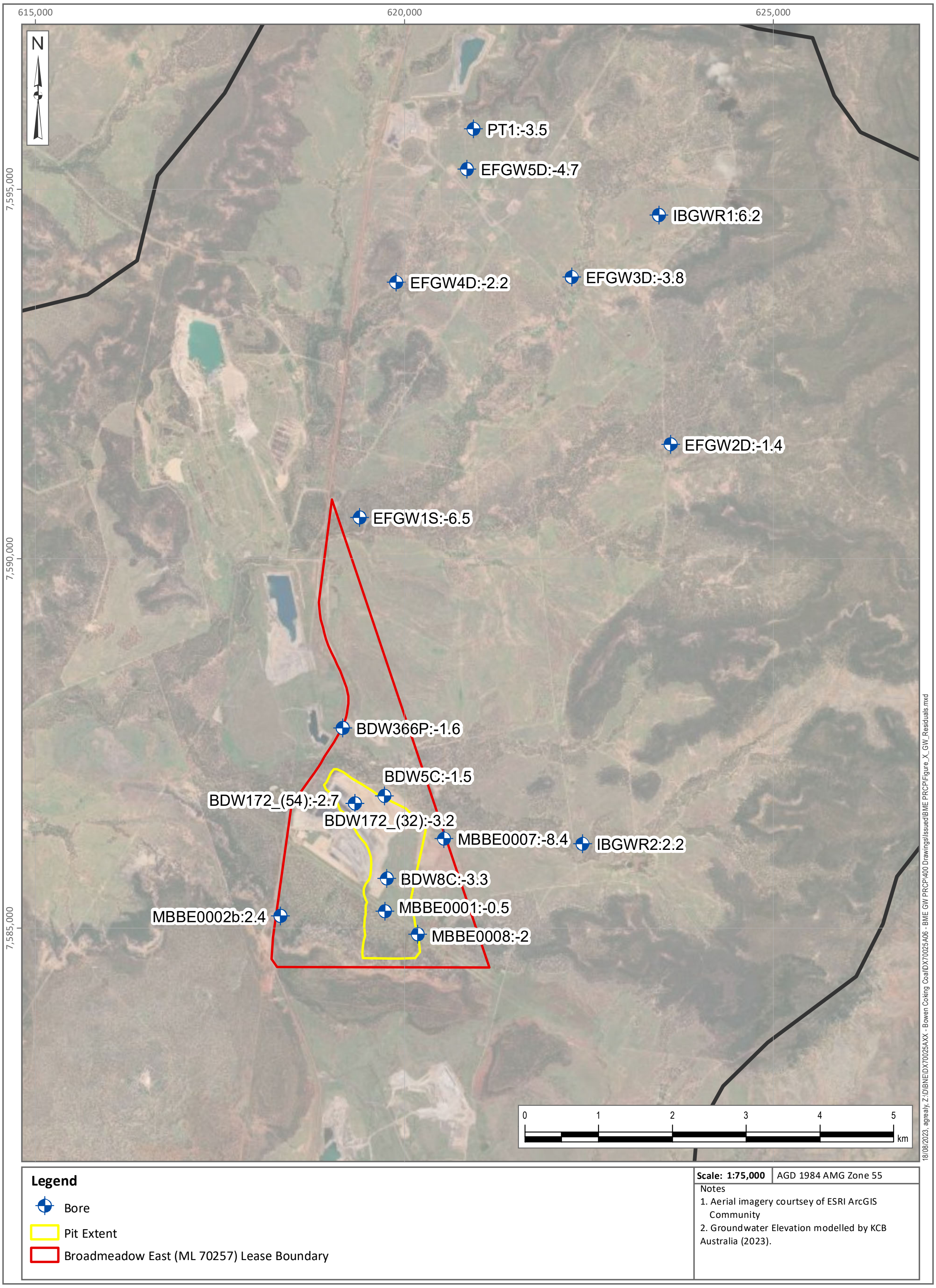


Figure IV-3.8 Residual plot map

Table IV-3.2 presents statistics from the calibration process. The scaled root Mean Square (SRMS) of errors from the calibration is 7.5%, which is within the guidance limits recommended by the Australian Groundwater Modelling Guidelines (Barnett et al. 2012) of 10% SRMS.

Table IV-3.2 Summary Model Calibration Performance

Statistical Metric	Value
Number of Observations	192
RMS error (m)	4.0
Scaled RMS (%)	7.5
Mean Sum of Residuals (m)	-2.1*
Scaled Mean Sum of Residuals (%)	-3.8
Correlation coefficient	0.89

**Negative value means overestimation; Positive value means underestimation.*

The groundwater elevation results for the end of the calibration period are shown in Figure IV-3.9.

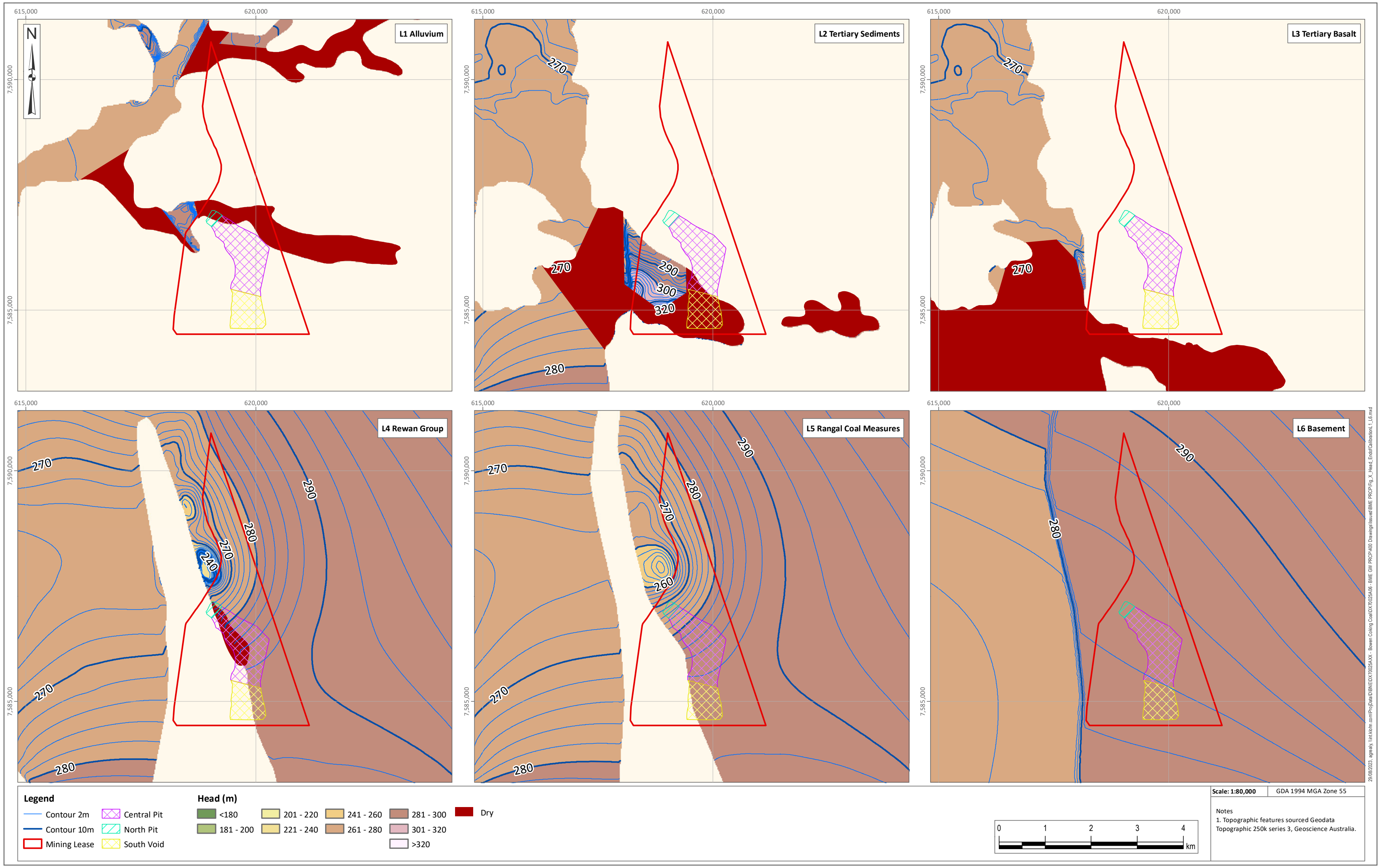


Figure IV-3.9 Groundwater Elevation at End of Calibration Period.

IV-3.10 Calibration Hydrographs

Hydrographs demonstrating the fit between modelled and measured observations, achieved through the calibration process, are shown in Figure IV-3.10.

The transient calibration results are based on monitored groundwater levels for each of the key hydrostratigraphic units within the vicinity of the Project area, in conjunction with data from monitoring bores located just outside of the Project area; which highlights the lateral and vertical distribution of the calibration targets.

Observed groundwater level monitoring records display seasonal variability, and these trends are successfully reflected by the transient calibration simulation. Therefore, the model calibration is considered robust and adequate for undertaking subsequent predictive simulations.

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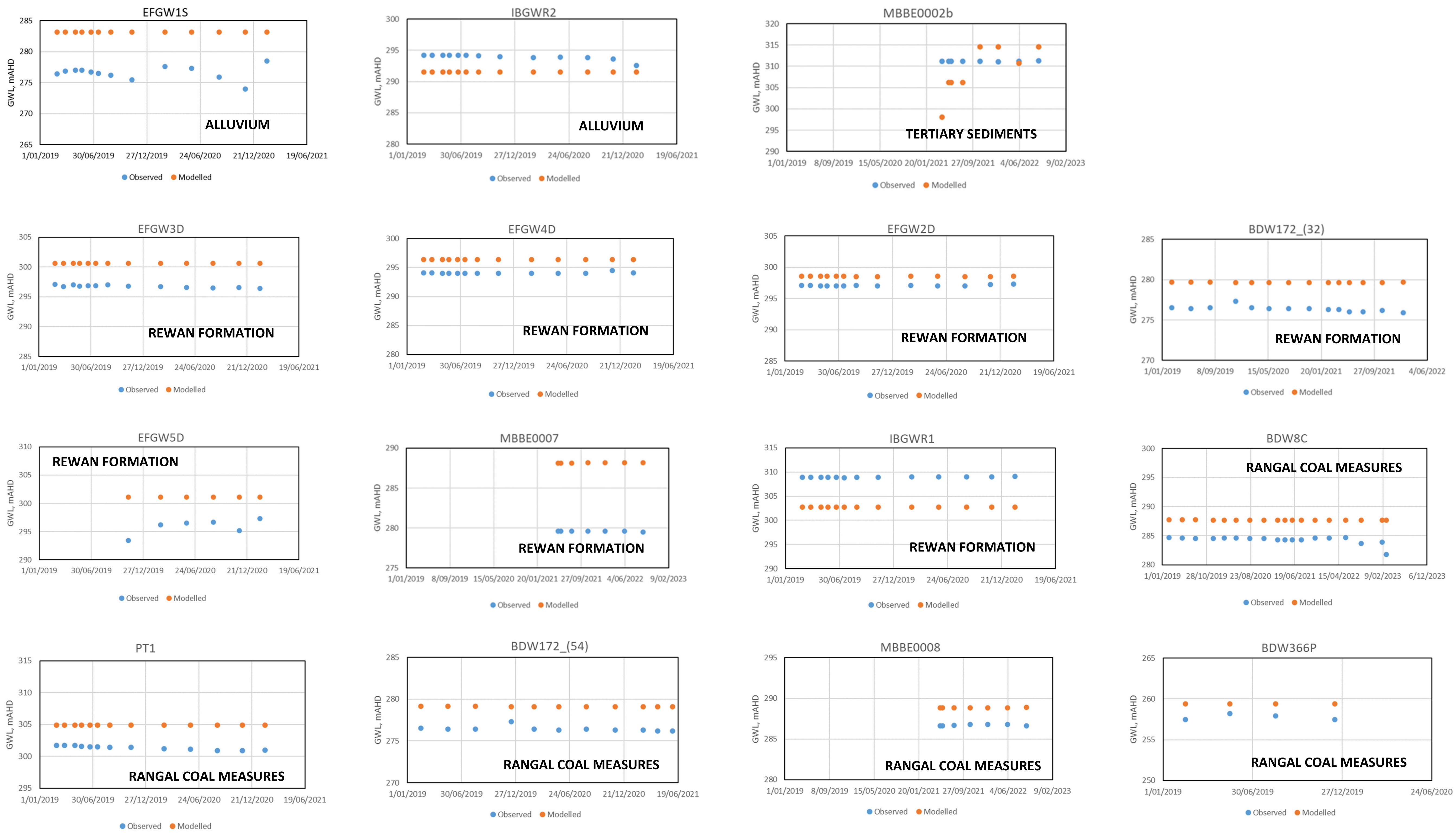

Figure IV-3.10 Modelled and Observed Hydrographs

IV-3.11 Calibrated Hydraulic Parameters

Table IV-3.3 provides a summary of calibrated hydraulic property values for each hydrostratigraphic unit represented in the model.

Table IV-3.3 Summary Calibrated Hydraulic Properties

Geological Unit	Calibrated Kxy (m/d)	Calibrated Kz (m/d)	Calibrated Specific Yield (-)	Calibrated Specific Storage (m^{-1})
Quaternary Alluvium	21.1	7.46	2.10E-01	5.13E-04
Tertiary Sediments	0.53	0.02	1.28E-03	4.86E-06
Tertiary Basalt	4.60	0.11	8.63E-03	2.64E-04
Rewan Group	0.0159	0.0011	7.08E-04	1.47E-05
Rangal Coal Measures	0.0037	0.0003	2.90E-03	1.33E-05
Fort Cooper Coal Measures	0.0019	4.33E-05	8.00E-04	3.14E-05

IV-3.12 Calibrated Recharge Rates

Recharge in the model was calculated as a percentage of recorded rainfall during each stress period of the calibration model run. Recharge values for the modelled recharge zones are provided in Table IV-3.4.

Table IV-3.4 Summary Calibrated Recharge Rates

Modelled Recharge Zone	Recharge (m/d)
Quaternary Alluvium	1.28E-06
Tertiary Sediments	9.32E-07
Tertiary Basalt	2.02E-07
Triassic and Permian Units	6.21E-08

IV-3.13 Calibrated Water Balance

The mass balance error of the transient calibration model represents the difference between model inflows and model outflows as calculated by the model. An error of approximately 1% is considered acceptable (Anderson and Woessner 1992). The water budget for the final stress period of the transient calibration model is presented in Table IV-3.5. The results indicate a water balance error of less than 1%, and therefore convergence of the numerical solution of the groundwater flow problem has been achieved.

Table IV-3.5 Summary Water Balance at the End of Calibration Period

Water Budget Item	Inflow (m^3/day)	Outflow (m^3/day)
Storage	0.4	200.4
Recharge (Rainfall deep drainage)	418.6	0
GHB Throughflow (Regional flow across model extents and Current mines)	1,342.6	1,561.1
Evapotranspiration (from surface heating/vegetation)	0	0
TOTAL	**1,761.6**	**1,761.6**
Mass Balance error	**<1%**	

IV-3.14 Sensitivity Analysis

A sensitivity analysis was performed to assess the response of the model to varying hydraulic properties and recharge rates. This analysis provides a comparison of the influence of these properties on the outcomes of predictions made by the model.

Parameters that were assessed during predictive sensitivities were grouped and varied in the following manner:

- Horizontal (Kh) and vertical (Kv) hydraulic conductivity of all layers was varied by 10 % above and below their calibrated values;
- Specific storage (Ss) and specific yield (Sy) values for all layers was varied by 10 % above and below their calibrated values; and
- Recharge rates were varied by 10 % above and below their calibrated values.

Table IV-3.6 Summary results from Sensitivity Analysis

Statistical Metric	Base Case	Conductivity × 0.1	Recharge × 0.1	Ss & Sy × 0.1	Conductivity × 10	Recharge × 10	Ss & Sy × 10
Number of Observations	192						
RMS error (m)	4.0	15.6	7.7	3.8	17.2	15	3.8
Scaled RMS (%)	7.0	29.1	14.3	7.0	32.0	27.8	7.0
Mean Sum of Residuals (m)	-2.1	-10.6	2.1	-1.4	10.7	-10.2	-1.5
Scaled Mean Sum of Residuals (%)	-3.8	-19.7	3.9	-2.7	19.8	-19	-2.8
Correlation coefficient	0.89	0.89	0.7	0.92	0.83	0.9	0.92

IV-3.15 Model Classification

Barnett et al. (2012) developed a system to classify the confidence level of groundwater flow models based on the calibration process used, as well as the predictive capability of the model. Three classes of models were developed for the BME model: Class 1, Class 2, and Class 3. A Class 3 model has the greatest confidence level, and a Class 1 model has the least. Factors to consider when determining model confidence level are:

- Data availability;
- Calibration procedures;
- Consistency between calibration and predictive analyses; and
- Stresses induced on the model.

The model outlined in this report is considered a Class 2 model because:

- A transient calibration was undertaken, and mining-induced groundwater trends have been replicated;

- Independent observations and calculations were used to support the calibration process; and
- The water balance error is less than 1%.

The model meets the criteria for a Class 2 model and exceeds the criteria for a Class 1 model. The exceedance of the Class 1 classification is driven by the following:

- Model is calibrated and key calibration statistics have been achieved;
- Calibration has been undertaken to transient conditions; and
- Model parameters are within the range of conceptualised hydraulic parameters.

The model is therefore classified as being a suitable tool for assessing groundwater impacts that may arise as a result of the Project.

IV-4 MODEL PREDICTIONS

IV-4.1 Predictions Overview

Simulations to support the PRCP included two stages:

1. Simulation of the remaining operations from the end of the calibration period (2023) to the end of operations (2028).
2. Simulation of post-closure for a period of 1,000 years.

IV-4.2 Remaining Operations Simulation

IV-4.2.1 Model Set-Up

A predictive simulation was carried out until the end of operations in 2028 using the calibrated transient model. This included completion of the mining schedule within the open pit.

The simulation comprised quarterly stress periods for a six-year duration starting at the final time step of the transient calibration, which represents current conditions. The future climate (rainfall and evaporation) sequence applied to the model was inferred from climate modelling data from CSIRO. Water levels in the voids for the remaining operations were provided by Engeny. All other boundary conditions were carried over from the transient model.

IV-4.2.2 Final Water Table

In Figure IV-4.1 the predicted difference in head between End of Calibration and End of Mining period is displayed.

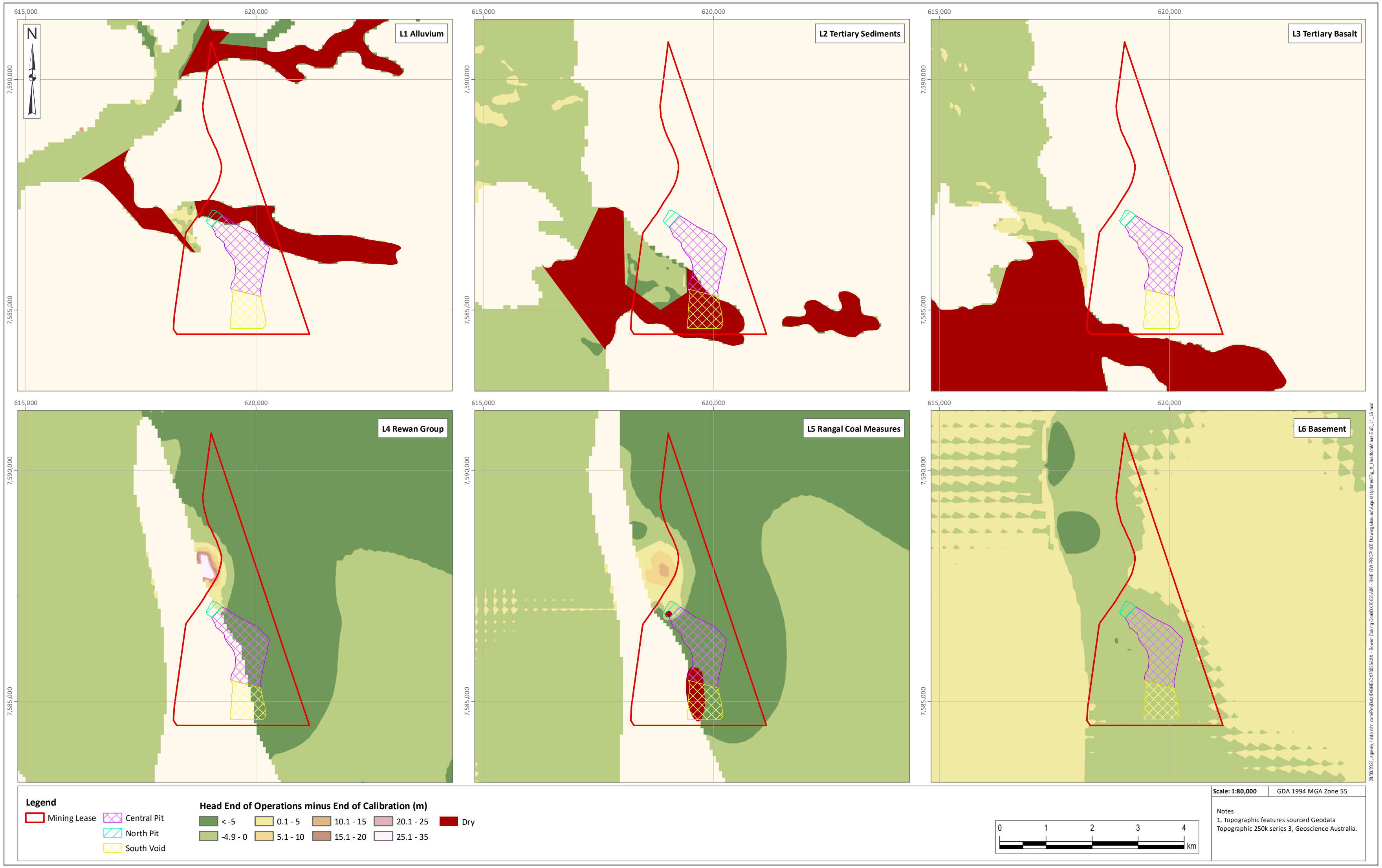

Figure IV-4.1 End of Operations Groundwater Head Difference – Model Layers

IV-4.3 Post-Closure

The simulation of post-closure groundwater conditions was undertaken to assess the final void water elevation within the proposed post-closure landform. The top surface of the model was updated to reflect the proposed post-closure landform, as shown in Figure IV-4.2. All active drains used to simulate dewatering were removed in the model to allow the system to recover.

Final pit void lake elevations were simulated by Engeny using a water balance model, as part of the surface water assessment. This water balance incorporated all contributing fluxes to the pit void, including the groundwater inflow.

The post-closure steady-state elevation of the pit void associated with the final landform were calculated by Engeny from the water balance model. The final void level was re-applied within the groundwater model using a GHB. Recharge and evaporation were not applied to the void as this was captured in the water balance model to identify the post-closure steady-state elevation.

The average final level for the southern void is 250 mAHD, with long-term water levels in the void varying from 242 to 256 mRL.

The elevations for the void were applied to the groundwater model, using a GHB to simulate the post-closure groundwater conditions. The difference in groundwater head between End of Calibration period and 1000-years post-closure is shown in Figure IV-4.3.

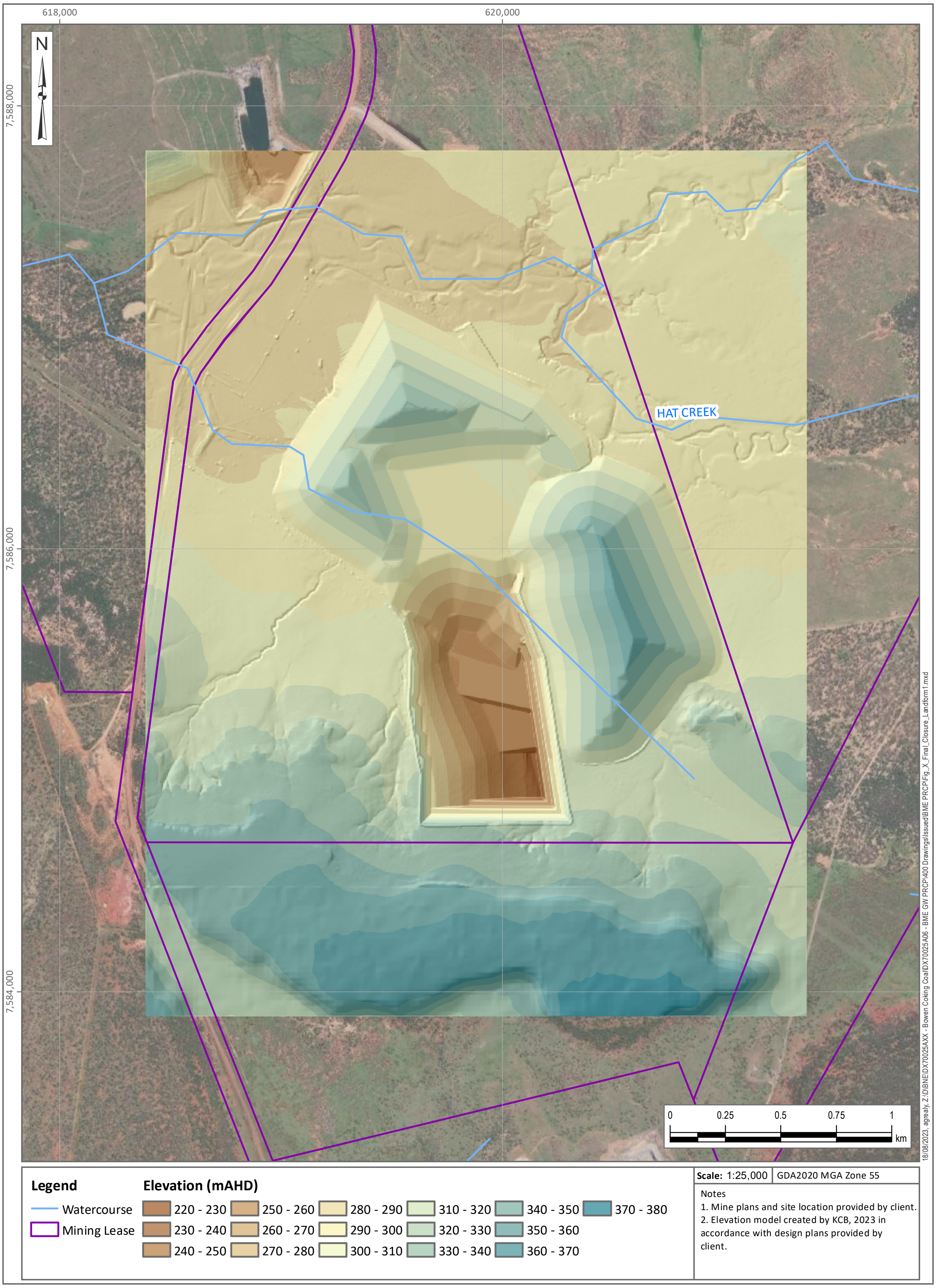

Figure IV-4.2 Final Landform Elevation and Void Modelled

Figure IV-4.3 Groundwater Head Difference for End of Calibration and 1000-years Post-closure – Model Layers

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ENGENY

BOWEN COKING COAL

Broadmeadow East Mine PRCP

Rehabilitation Flood Assessment

QC1015_005-REP-001-1

13 SEPTEMBER 2023

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	23/08/2023	Client Issue	Sean Willis	Chris Harris	Chris Harris	Samantha Breslin
1	13/09/2023	Client Issue	Sean Willis	Chris Harris	Chris Harris	Samantha Breslin
Signatures:						

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Figures

1. INTRODUCTION

Engeny Australia Pty Ltd (Engeny) has been engaged by Bowen Coking Coal (BCC) to undertake a final landform rehabilitation flooding assessment of the Broadmeadow East (BME) Mine.

BME is an open cut coal mine located entirely within Mining Lease (ML) 70257. BCC purchased the 845-hectare (ha) ML 70257 from Peabody (Burton Coal) Pty Ltd, which led to the de-amalgamation from nearby tenures and associated Environmental Authority (EA) on 24 August 2020. BME is authorised under EA0002465, last issued on 2 February 2023.

BCC is preparing the transitional Progressive Rehabilitation and Closure Plan (PRCP) for BME. This report details the flood modelling assessment conducted of the rehabilitated final landform at BME presents its susceptibility to impact/risks due to flooding. It has been prepared to address Section 3.6.1 'Flooding' of the Department of Environment and Science (DES) PRCP Guideline (DES, April 2023).

1.1 Background

Engeny previously assisted BCC with the development of a preliminary flood model for BME, as detailed in '*Broadmeadow East Project Surface Water Impact Assessment*' dated 17 September 2021 (ref. M7284_001-REP-1). This model has been revised and updated for the purpose of the PRCP assessment to utilise latest information.

1.2 PRCP Guideline Section 3.6.1 Flooding

This report addresses the following information requirements (direct excerpts) from the DES PRCP Guideline Section 3.6.1 'Flooding':

Flooding

"the applicant must also assess the flooding susceptibility and influence across the site. If flooding is a consideration, develop a hydrologic model of the catchment and a hydraulic model of the proposed mining area. Knowledge of flooding is integral to the rehabilitation planning process, including the placement and design of mine domains. When assessing flooding, you must at least:

- *consider the location of domains in relation to potential flood levels*
- *consider alteration of flow upstream and downstream*
- *model flood levels (including probable maximum flood levels) for a range of design storm events*
- *develop a flooding risk profile."*

2. SITE INFORMATION

BME is located 22 km northeast of Moranbah township and 120 km southwest of Mackay in the Queensland Bowen Basin. Refer to Figure 2.1 for further information.

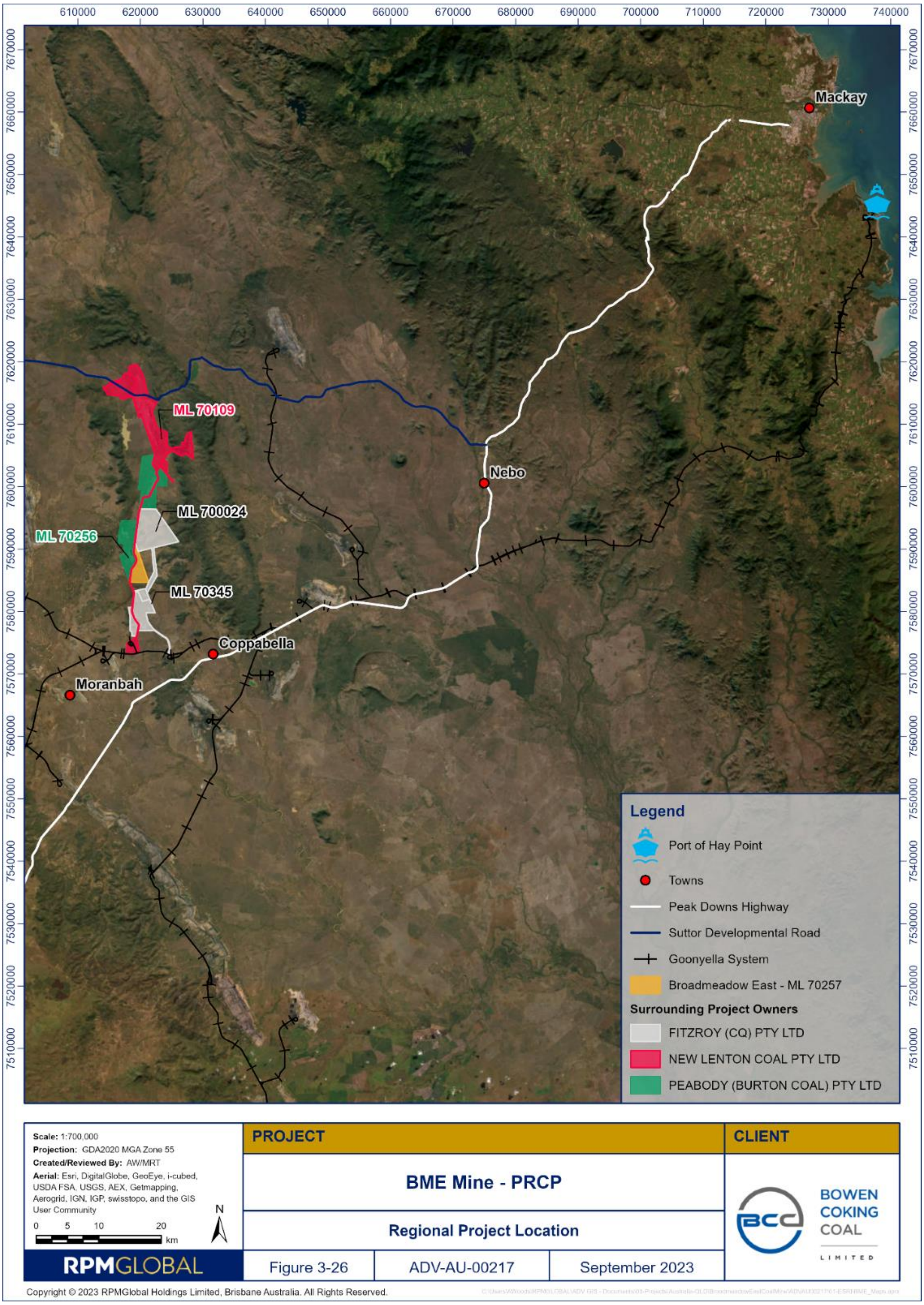

Figure 2.1: Site Location

2.1 Existing Site Topography

Topographic data for BME includes detailed 5m Digital Terrain Model (DTM) within the ML boundary, and 25m Shuttle Radar Topography Mission (SRTM) DEM for the topography outside of the ML. The existing topography consists of several unnamed and named waterways, ranging from minor to non-perennial waterways. All waterways are ephemeral in nature. The largest of the waterways that traverse the ML is Hat Creek, which runs through the middle of the ML, directly adjacent to the northern extent of the mine footprint. Hat Creek is a minor tributary of Teviot Brook, which it joins with downstream of the site boundary.

BME abuts the Peabody Coal Broadmeadow West Mine to the west (ML70256). No public roads are located within the ML, only a series of private farm access tracks and a private haul road that runs adjacent to the entire length of the western side of the ML (ML 70109). Refer to Figure 2.2 for further information.

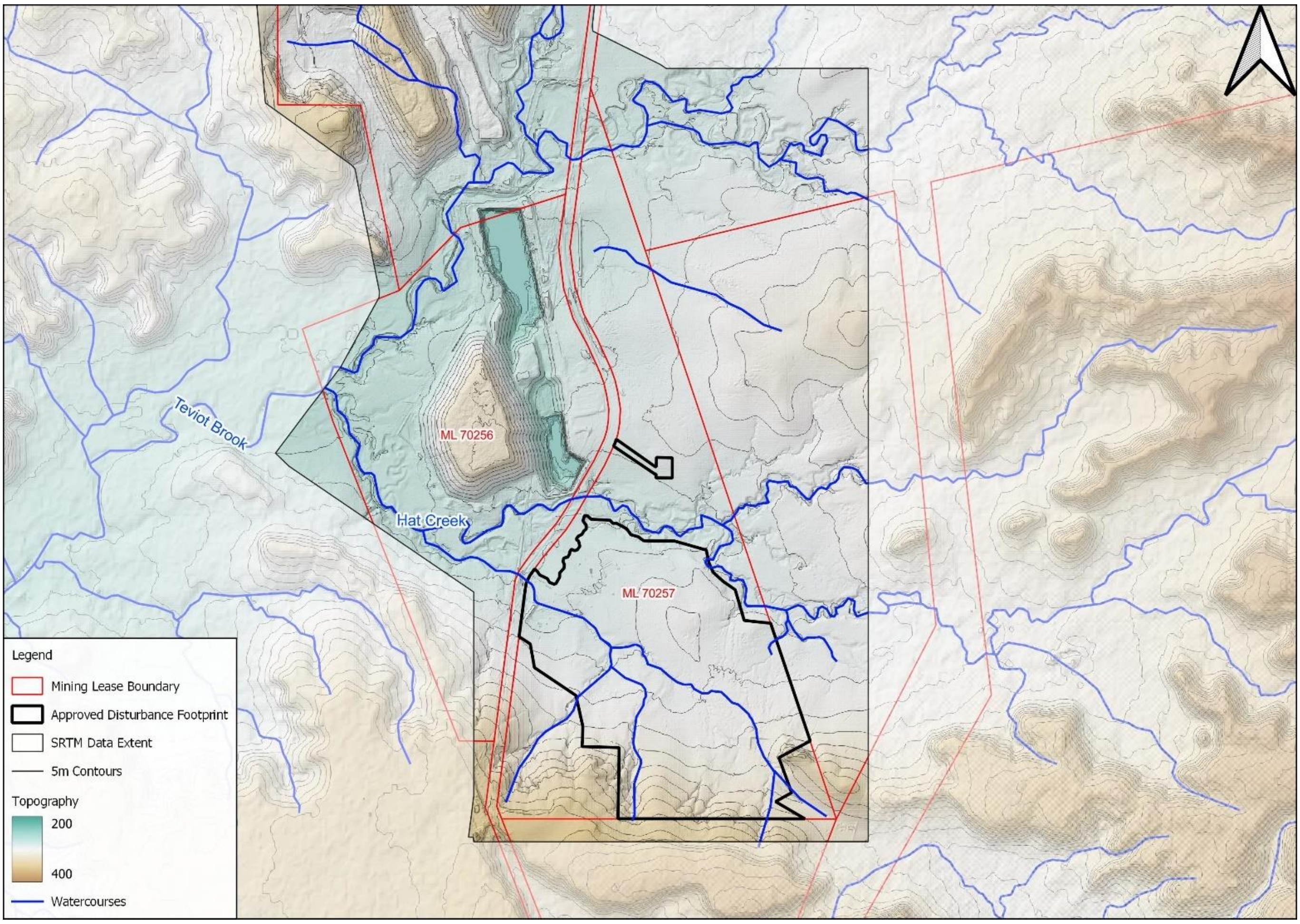

Figure 2.2: Existing Site Topography

2.2 Final Landform

Mining at BME has begun at the northern portion of the proposed pit area and is progressively occurring along the resource in a southerly direction. The northern portion of the pit will be partially backfilled and kept available for use as bulk water storage during operation. Prior to closure, the bulk water storage will be filled to the surrounding topography at the end of mine life when no longer required.

The initial overburden has been placed in the two Out of Pit Dumps that will be constructed over the operational period prior to rehabilitation works. Overburden will also be placed within the pit as mining progressively moves south, leaving one final void in the southern extent of the pit (South Pit). South Pit drainage and pit protection infrastructure (e.g. bund/road) along the South pit highwall is proposed to remain post-closure to direct surface water around South Pit towards Hat Creek to the North. This ensures the natural catchment area (~35 ha) that would otherwise report into the pit, is instead redirected towards Hat Creek and retained in the receiving environment catchment. The final landform for BME is shown in Figure 2.3.

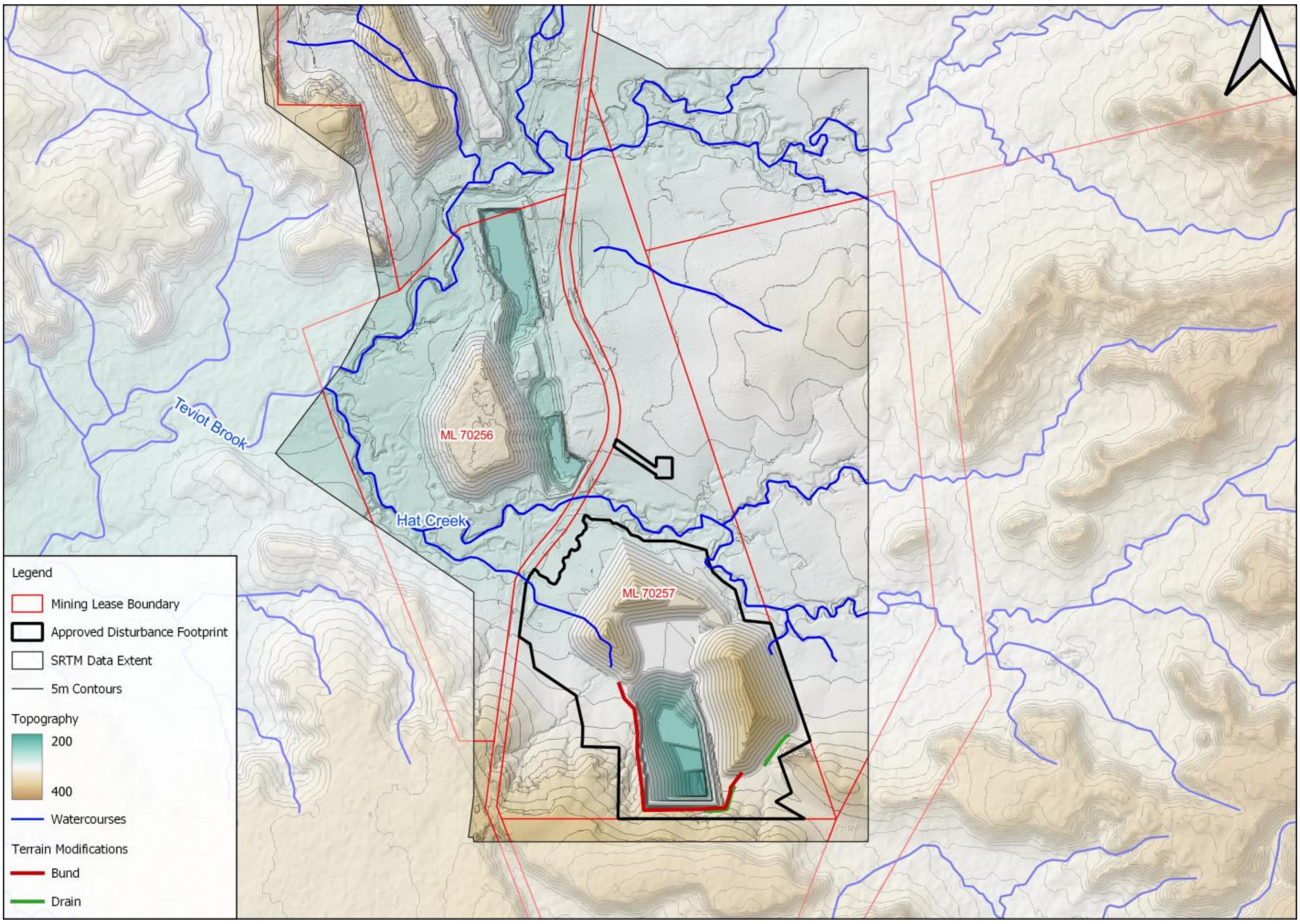

Figure 2.3: Final Landform Design

3. HYDROLOGY

Engeny has developed a runoff routing hydrological model using Watershed Bounded Network Model (WBNM). The following sections of this report detail the inputs for the WBNM built for BME and the hydrological outputs.

3.1 Catchment Inputs

Sub-catchment delineation for BME was developed using the final landform topography previously displayed in Figure 2.3. The hydrological model extends from the upper reaches of the Hat Creek catchment to just upstream of the Teviot Brook Hat Creek confluence and includes a total area of approximately 39 km^2. Note, that for the purposes of the WBNM, catchments need to have an identified downstream reporting catchment, i.e., where the flow is supposed to report to next. For the purposes of modelling the void, all surrounding catchments have been simulated as if reporting directly to the void. However, when it comes to the hydraulic simulation, these sub-catchments will be locally applied around the void, to capture the local drainage situations.

The final landform is proposed to be fully rehabilitated apart from the base of the South Pit, therefore the hydrology model has assumed no impervious surfaces remain and a 0% impervious fraction (F_i) for catchments other than the South pit void (FL_27).

Figure 3.1 provides the BME sub-catchment extents used for the WBNM, and Table 3.1 provides the catchment inputs for WBNM.

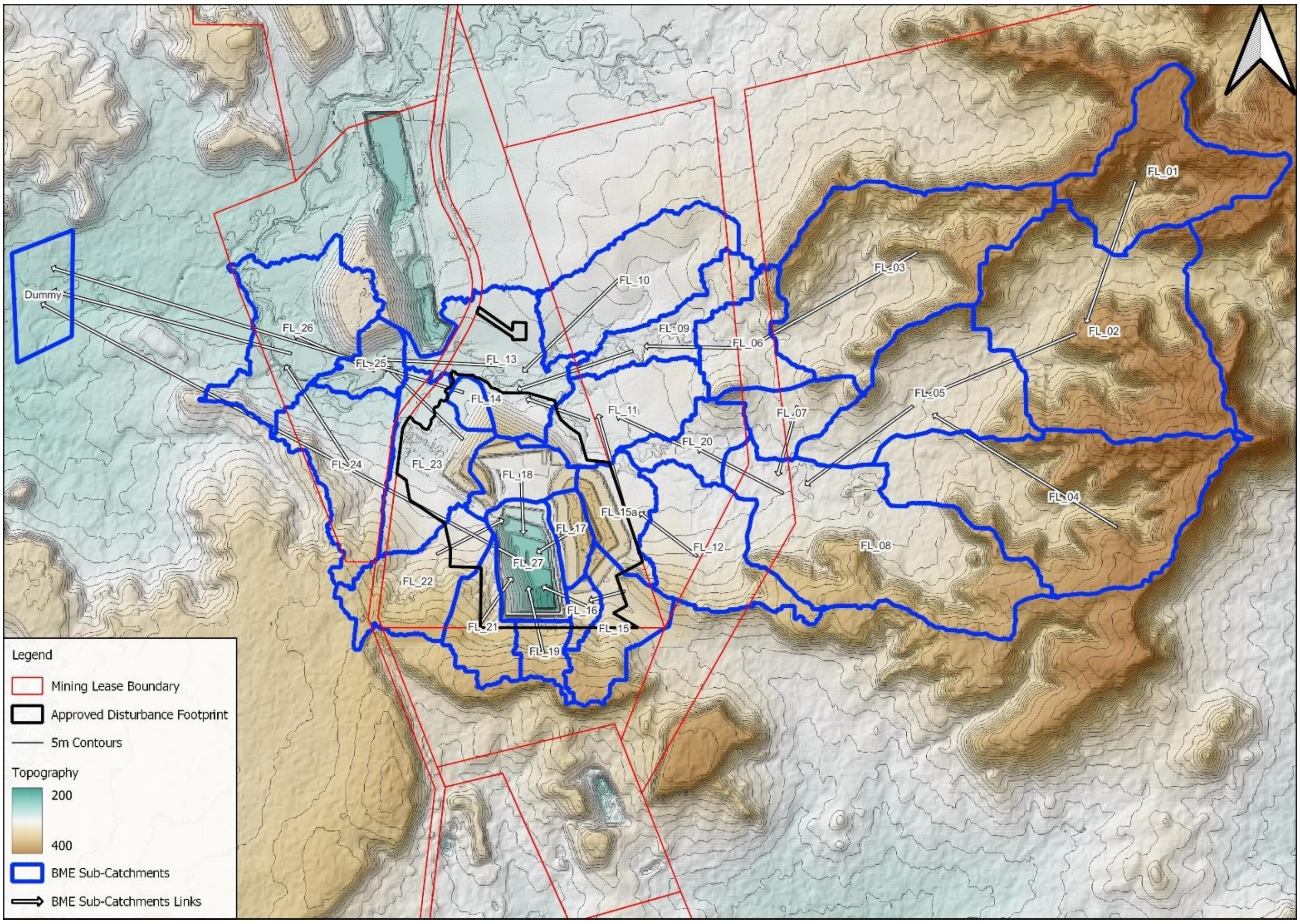

Figure 3.1: BME WBNM Sub-Catchments

TABLE 3.1: BME WBNM SUB-CATCHMENT INFORMATION

ID	Total Area (ha)	ID	Total Area (ha)
FL_01	203.52	FL_16	17.71
FL_04	401.56	FL_21	68.11
FL_02	452.32	FL_22	117.31
FL_03	357.5	FL_20	58.31
FL_06	88.84	FL_15A	69.58
FL_15	88.59	FL_09	78.88
FL_12	155.64	FL_10	175.53
FL_05	212.32	FL_11	125.65
FL_07	68.27	FL_23	132.33
FL_08	366.53	FL_13	147.57
FL_18	60.91	FL_24	147.21
FL_19	33.2	FL_25	44.32
FL_17	31.69	FL_14	17.75
Total			**3982.39**

3.2 Hydrological Inputs

The following sections detail the hydrological inputs, gathered in accordance with the Australian Rainfall & Runoff 2019 (ARR2019) Guidelines.

3.2.1 Design Rainfall

The 50% AEP (1.44yr), 20% AEP (4.48yr), 10% AEP (10yr), 1% AEP (100yr) and 0.1% AEP (1000yr) were sourced using the Australian Rainfall and Runoff 2019 IFD generation tool available on the Bureau of Meteorology (BoM) website (www.bom.gov.au), at Latitude 21.817, Longitude 148.184. Areal Reduction Factors (ARF) have been applied for all design events, and pre-burst depths have been applied for the 50% to 1% AEP events.

3.2.2 Extreme Events

The Probable Maximum Precipitation (PMP) was determined using the *Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*, (BoM, 2003). PMP rainfall was estimated using the Generalised Short Duration Method (GSDM) for up to the 6-hour duration.

3.2.3 Temporal Patterns

Design events (50% - 0.1% AEP) have utilised the 'East Coast North' point temporal patterns, with all ten temporal patterns being simulated. Durations assessed range from 1 hour to 36 hours.

For the PMP event, the full historical ensemble of ten temporal patterns (plus AVM) have been simulated. Durations simulated range from 30 minute to 6 hours.

3.2.4 Initial and Continuing Losses

For pervious surfaces, an initial and continuing loss of 40 mm and 2.7 mm/hr have been used respectively, as per the ARR 2019 data. For impervious surfaces, an initial and continuing loss of 1 mm and 0 mm/hr have been used respectively.

For the PMP event, an initial and continuing loss of 0 mm and 1 mm/hr has been used for pervious surfaces.

3.2.5 Other Model Parameters

The default stream lag factor of 1.0, pervious lag parameter of 1.6 and impervious lag parameter of 0.1 have been adopted for the WBNM.

3.2.6 Climate Change Assessment

Two climate change sensitivity assessments have been proposed for this stage of final landform assessment, an RCP 4.5 and RCP 8.5 for 2090. This corresponds to a rainfall factor of 9.5% and 19.7% respectively and will be simulated for the 1% and 0.1% AEP events.

3.3 Model Calibration & Validation

3.3.1 Model Calibration

A model calibration to a known historical event was unable to be completed for the site, as Hat Creek does not have any known / active gauging stations.

3.3.2 Model Validation

The 1% AEP peak flow for Hat Creek was validated using two available methods: the Regional Flood Frequency Estimation (RFFE) Method (ARR, 2021) and the Queensland Quantile Regression (QRT) Method (QRT, 2011). Due to the lack of information surrounding the Hat Creek catchment, the variance between assessments is considered acceptable for this level of assessment.

TABLE 3.2: HAT CREEK PEAK FLOW VALIDATIONS

Event	WBNM Peak Flow (m^3/s)	QRT Peak Flow Estimate (m^3/s)	RFFE Peak Flow Estimate (m^3/s)
1% AEP	190.2	302	58.2

3.4 Model Results

For the purposes of identifying the critical events to simulate in the hydraulic model, two focus points have been identified; the critical events at the Hat Creek Teviot Brook confluence (FL_26) and the critical events for the catchments reporting to the void (FL_27). The peak flow, critical duration, and temporal pattern for each of these catchments for all simulated events have been provided in Table 3.3.

TABLE 3.3: BME WBNM PEAK FLOW RESULTS

	Hat Creek Teviot Brook Confluence (FL_26)		BME Void and Surrounding Catchments (FL_27)	
Event	Peak Flow (m^3/s)	Critical Duration & Temporal Pattern	Peak Flow (m^3/s)	Critical Duration & Temporal Pattern
PMF	1695.0	3hr_tp1	384.1	1.5hr_tp8
0.1% AEP	340.7	6hr_tp1	83.9	1.5hr_tp7
1% AEP	190.2	6h_tp3	42.5	6hr_tp10
10% AEP	88.7	6hr_tp7	25.5	3hr_tp6
20% AEP	58.5	12hr_tp2	17.0	9hr_tp6
50% AEP	25.5	24hr_tp10	7.2	18hr_tp9

TABLE 3.4: BME WBNM PEAK FLOW RESULTS – CLIMATE CHANGE EVENTS

	Hat Creek Teviot Brook Confluence (FL_26)		BME Void and Surrounding Catchments (FL_27)	
Event	Peak Flow (m^3/s)	Critical Duration & Temporal Pattern	Peak Flow (m^3/s)	Critical Duration & Temporal Pattern
0.1% AEP 2090 RCP 8.5	426.1	6hr_tp1	108.3	1.5hr_tp11
0.1% AEP 2090 RCP 4.5	381.9	6hr_tp1	96.3	2hr_tp11
1% AEP 2090 RCP 8.5	242.8	6hr_tp3	58.3	2hr_tp8
1% AEP 2090 RCP 4.5	213.9	6hr_tp8	51.3	2hr_tp8

4. HYDRAULICS

Engeny has developed a two-dimensional hydraulic model using TUFLOW. The following sections detail the key model inputs and then go on to review the hydraulic results.

4.1 Model Inputs

4.1.1 Boundary Conditions

The inflow boundary conditions apply the hydrographs generated for the sub-catchments identified in Figure 3.1 to the hydraulic model. Flows have been applied using a flow over area boundary, with the location of these boundaries being based on the sub-catchments they apply the flow for. The outflow boundary condition has used an auto-generated stage-discharge relationship based on an outlet slope of 0.1%. Note this does not consider the hydrological impact of Teviot Brook, and so hydraulic results from this assessment should not be considered for this area. The location of all boundary conditions is provided in Figure 4.1.

4.1.2 Surface Roughness

The hydraulic roughness (Manning's 'n') values applied in the TUFLOW model were adopted based on aerial imagery and channel geometry. The adopted Manning's 'n' Roughness values are summarised in Table 4.1, with the modelled extent provided in Figure 4.1.

TABLE 4.1: MANNING'S ROUGHNESS

Land Use	Manning's 'n'
Waterway	0.035
Riparian Zone	0.06
Floodplain	0.05

4.1.3 Topography Modifications

An initial review of the supplied final landform identified several locations where drainage around the South Pit and the southern toe of the OOPD had not initially been considered. To that end, several high-level topographic modifications have been introduced to the final landform, in the form of either flood protection bunds, or drainage channels. These topographic modifications are only conceptual and will require further investigation to identify the optimal design. The location of these modifications is provided in Figure 4.1.

4.1.4 Hydraulic Structures

An existing haul road crosses Hat Creek, directly downstream of the ML boundary, north of the BME site. A site inspection in late 2020 confirmed that this structure is 100% blocked, and therefore has not been modelled. Upgrades are currently proposed for this haul road but conservatively have not been included in the modelling.

It is noted that as this assessment is meant to be for the final landform as part of the PRCP assessment, typically crossings such as this are required to be removed. However, this haul road services other mines outside of BME, and therefore will still be required.

4.1.5 Climate Change

The climate change events referenced in Section 3.2.6 have been simulated using the relevant climate change hydrographs.

4.1.6 Model Resolution & Time Step

The latest TUFLOW GPU/HPC version has been used for this assessment, which involves a variable time step for the model to provide stable hydraulic results. A model cell size of 5m has been used for this assessment.

4.1.7 Model Assumptions & Limitations

Key model assumptions and limitations that are known and need to be considered when utilising the hydraulic outputs of this assessment are provided in Table 4.2.

TABLE 4.2: MODEL ASSUMPTIONS AND LIMITATIONS

Assumption and/or limitation	Section Location
Hydrology and hydraulic modelling have only been completed up to the confluence of Hat Creek and Teviot Brook. Teviot Brook and its associated hydrological flows has not been considered. Therefore, hydraulic results beyond the mine lease boundary should not be used.	Section 3.1 and 4.1
No hydrological or hydraulic model calibration has been completed for this assessment as there is insufficient historical data. It is advised that over the course of BME's mine life, this data begin to be collected with onsite rain and streamflow gauges.	Section 3.3.1
The existing haul road through Hat Creek has been maintained as part of the PRCP assessment, as it will ultimately still be required to service other sites post closure of BME and may remain for other accessibility purposes.	Section 4.1.5

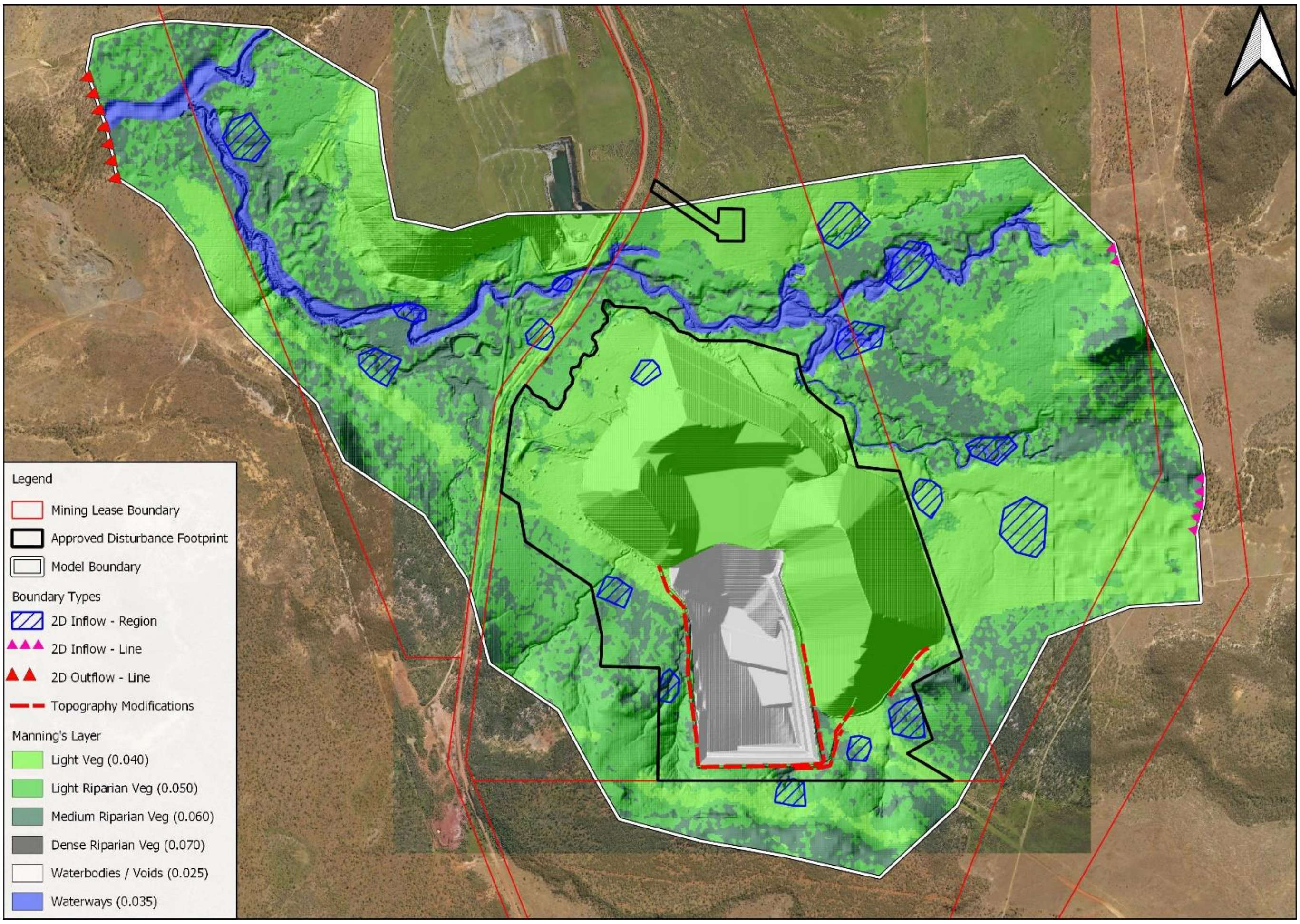

Figure 4.1: BME Final Landform TUFLOW Build

4.2 Hydraulic Results

The flood depth and velocity maps for the 50%, 20%, 10%, 1%, 0.1% AEP events and the PMF have been provided in Appendix A. The flood depth and velocity maps for the 1% and 0.1% AEP 2090 RCP 4.5 and 8.5 climate change events have been provided in Appendix B.

5. FLOODING RISK PROFILE

The 0.1% AEP and PMF flood depth and velocity mapping around the final landform have been extracted from Appendix A. The 0.1% AEP flood depth and velocity results have been extracted and are provided in Figure 5.1 and Figure 5.2 respectively. The PMF flood depth and velocity results have been extracted and are provided in Figure 5.3 and Figure 5.4 respectively.

Further to these results, cross sections in two areas adjacent to the constructed final landform have been extracted, providing flood levels and velocities. These have been attached as Appendix C.

These results highlight the following risks to the rehabilitated final landform:

- Drainage is required around the southern edge of the void and eastern landform. This has been incorporated within the hydraulic model based on concept drainage pathways along the southeastern edge of the void and landform. It is noted that minor reshaping may be required for the OOPD, to provide these drainage pathways. The final void footprint is satisfactory in that the local drainage works outside of the current footprint are feasible.
- Flood ingress into the void occurs during the PMF event. No flood ingress into the void occurs during the 0.1% AEP event. The final bund height was set to be above the 0.1% AEP flood depth and is intended as conceptual only. Void inflows are caused by local catchment runoff only and it is not anticipated that flooding within Hat Creek would generate any inflows to the void based on the flood results and ground levels.
- In the 0.1% AEP event, depths adjacent to the final landform range from approximately 1 – 1.5m. In the PMF event, depths adjacent to the final landform range from 2 – 2.5m.
- In the 0.1% AEP event, velocities adjacent to the final landform range from approximately 1.5 – 3.5m/s. In the PMF event, velocities adjacent to the final landform range from 2 – 3.5m/s. It is therefore recommended that these locations are suitably protected (i.e. with rock, or some alternative form of armouring), to minimise scour potential and ensure the longevity of the final landform.

Figure 5.1: 0.1pct Flood Depth Around Final Landform

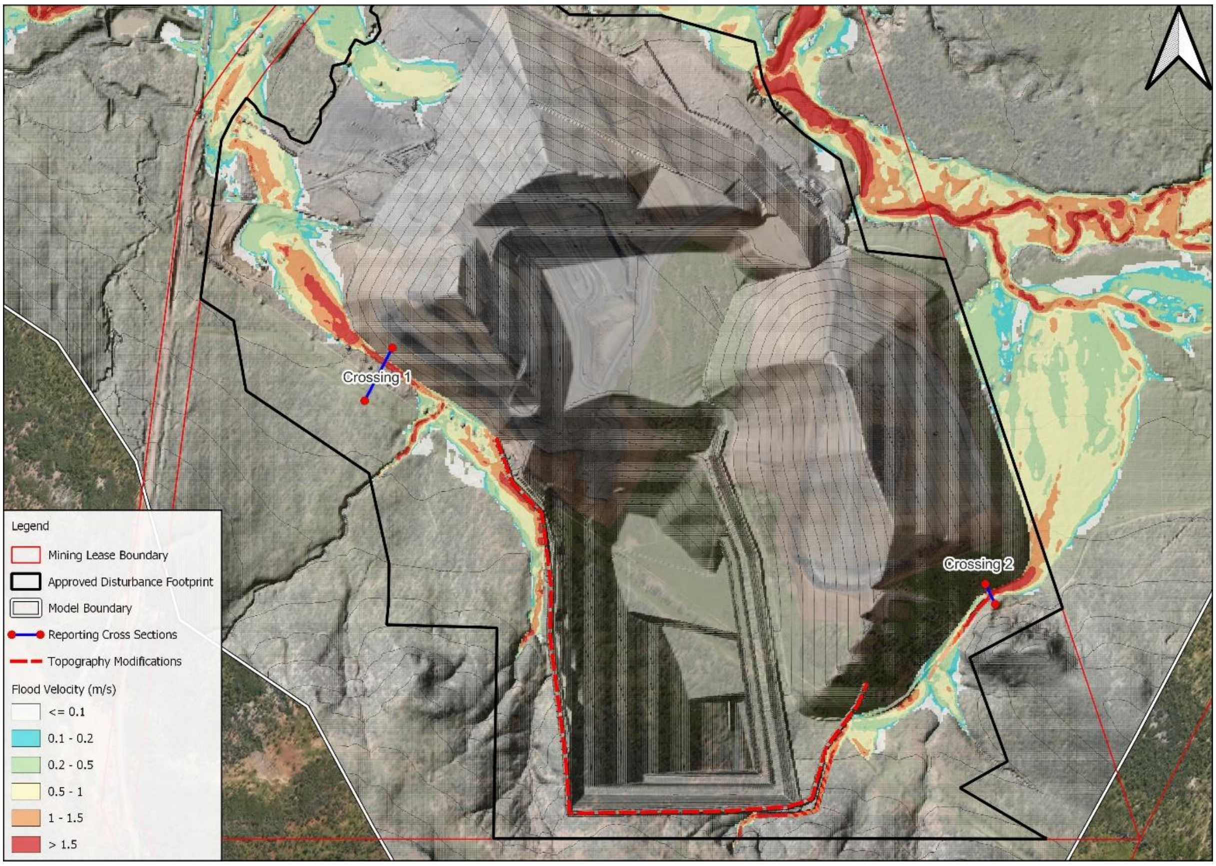

Figure 5.2: 0.1pct Flood Velocity Around Final Landform

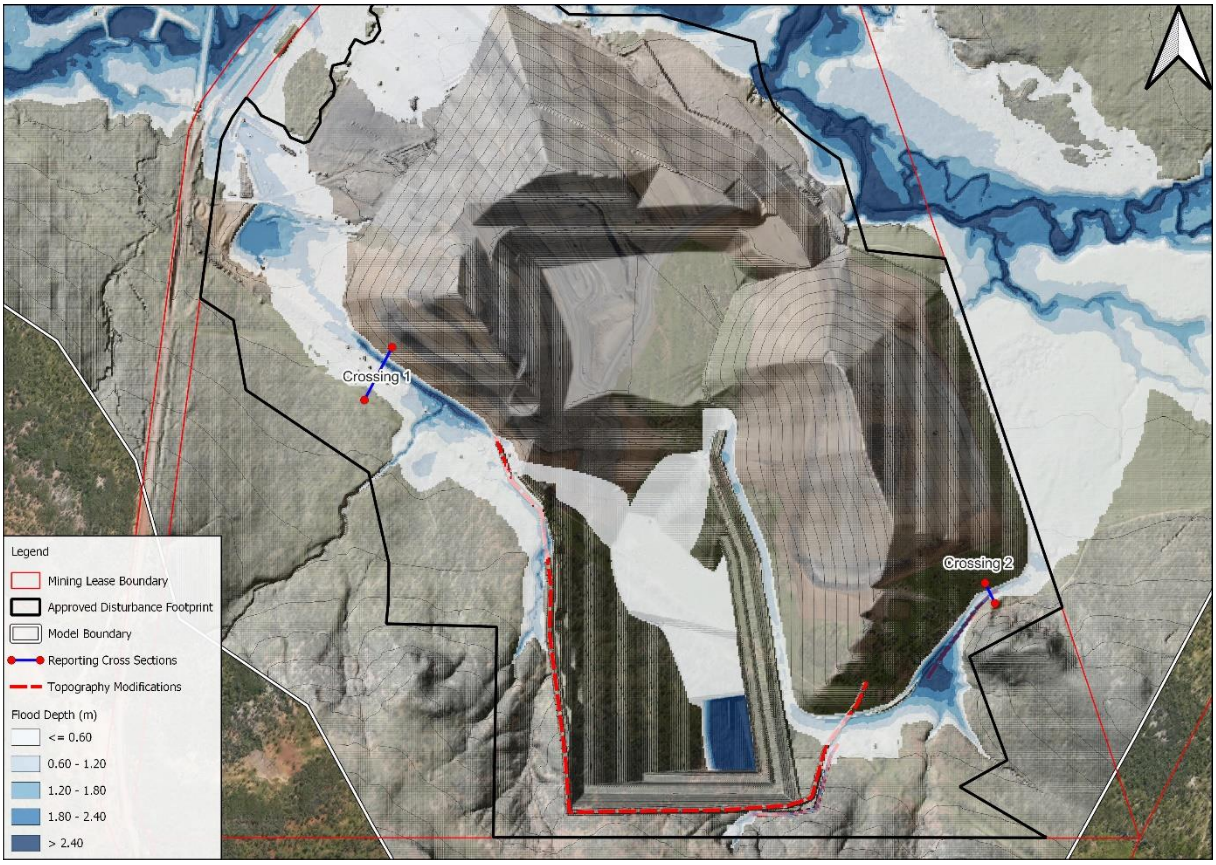

Figure 5.3: PMF Flood Depth Around Final Landform

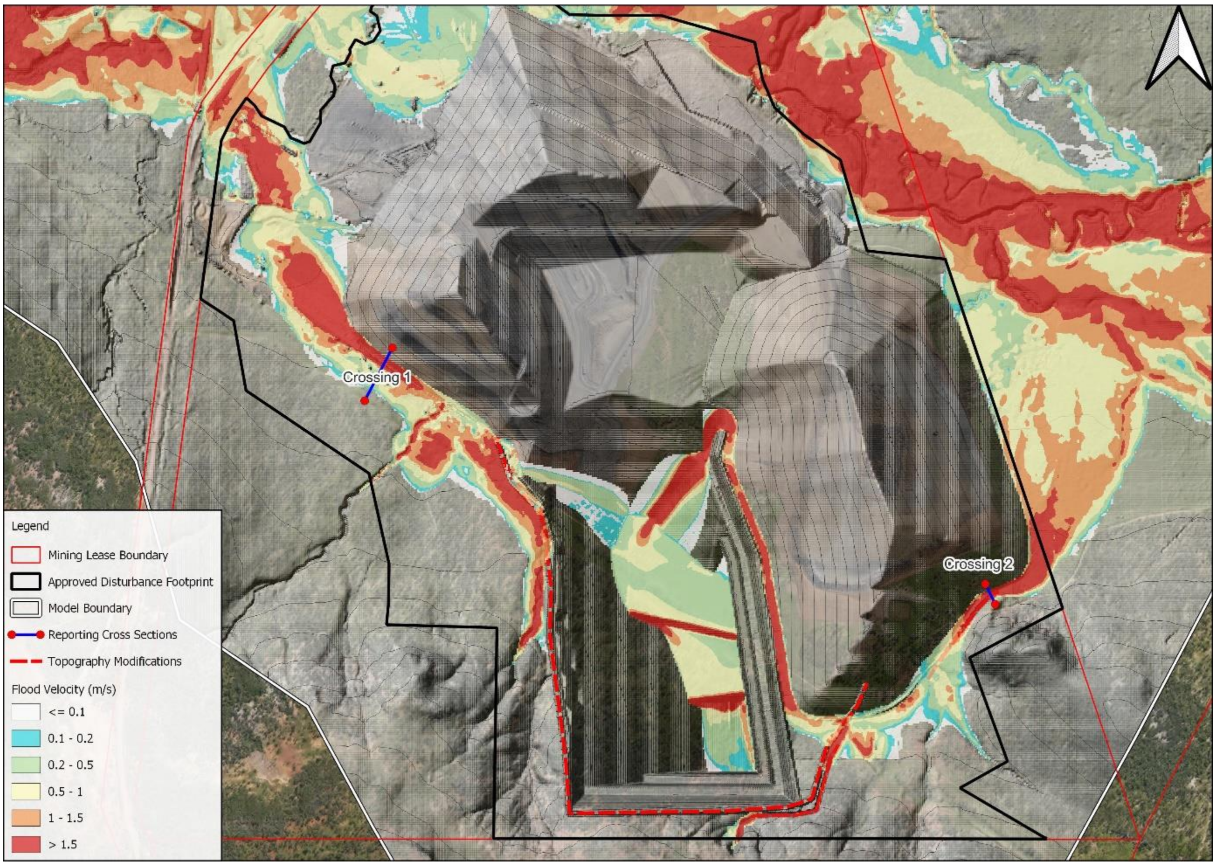

Figure 5.4: PMF Flood Velocity Around Final Landform

6. QUALIFICATIONS

(a) In preparing this document, including all relevant calculation and modelling, Engeny Australia Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

(b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

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(g) This Report does not provide legal advice.

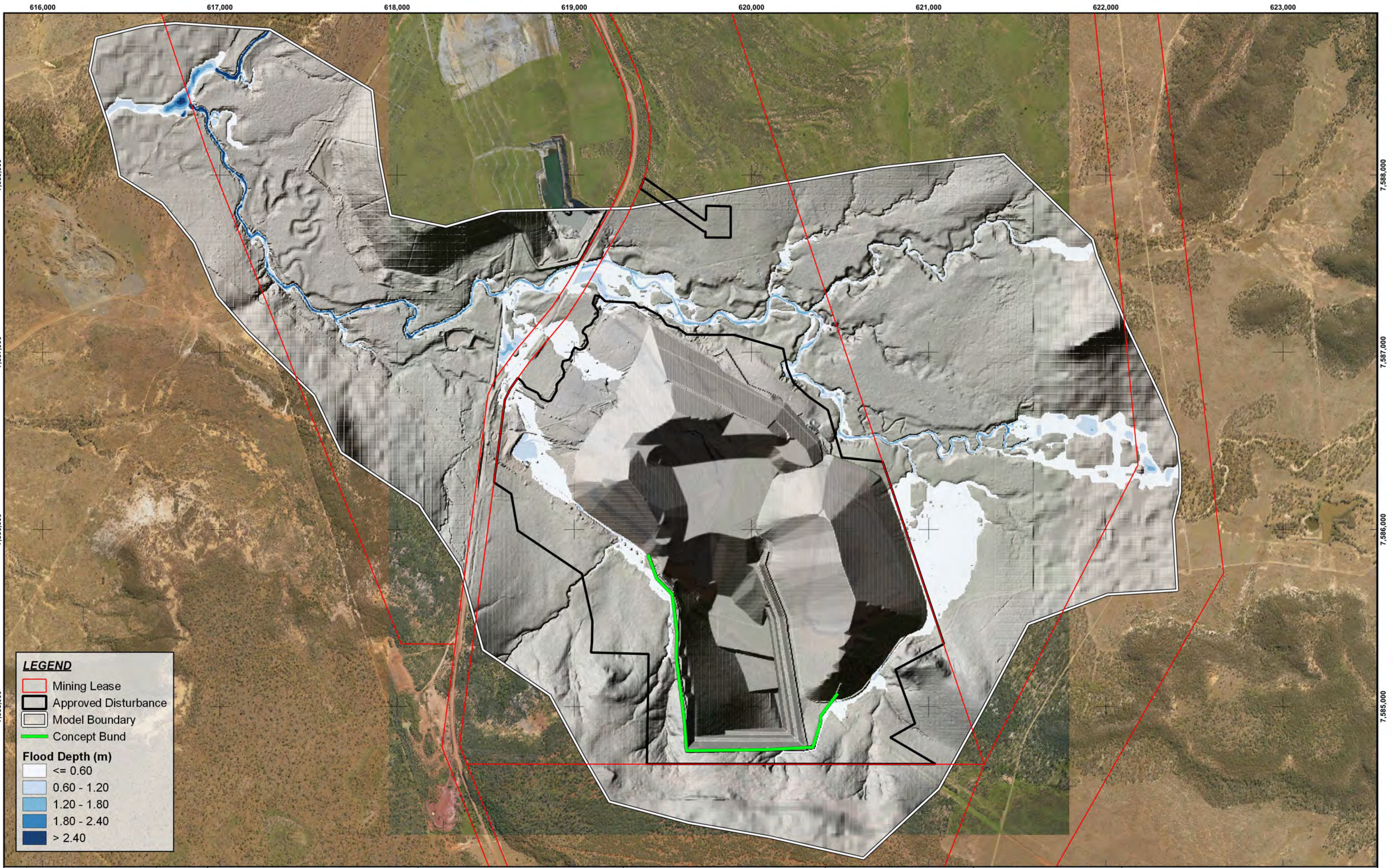
7. REFERENCES

DES. (2020, August 24). Environmental authority EPML00879213.

DES. (2021). Environmental Authority EA0002465.

Geoscience Australia. (2019). Australian Rainfall and Runoff: A Guide to Flood Estimation

APPENDIX A: DESIGN FLOOD EVENTS



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Appendix A1 - 50% AEP Flood Depth

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref.
QC1015_005-FIG-Appendix A1

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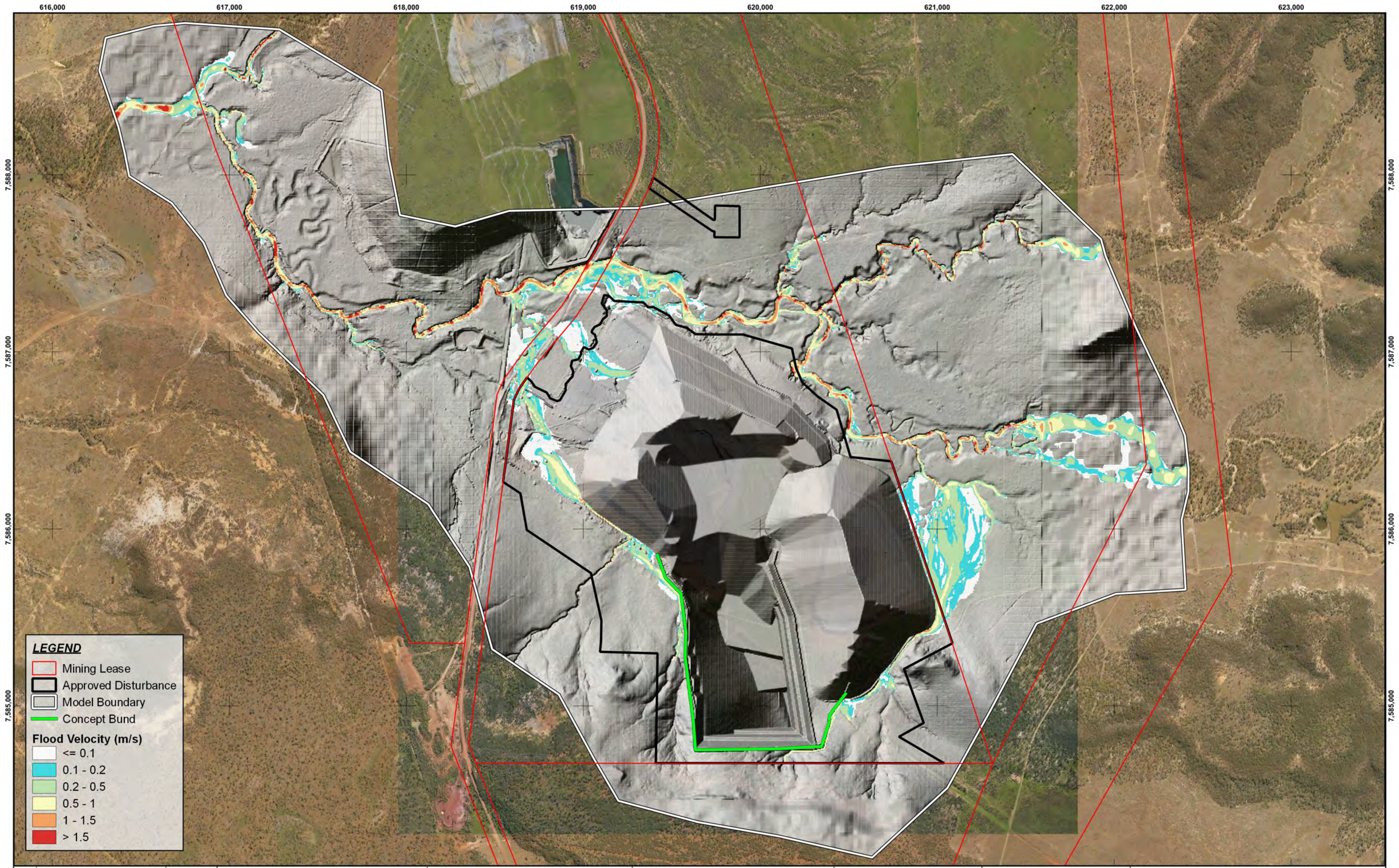

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Appendix A2 - 50% AEP Flood Velocity

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref.
QC1015_005-FIG-Appendix A2

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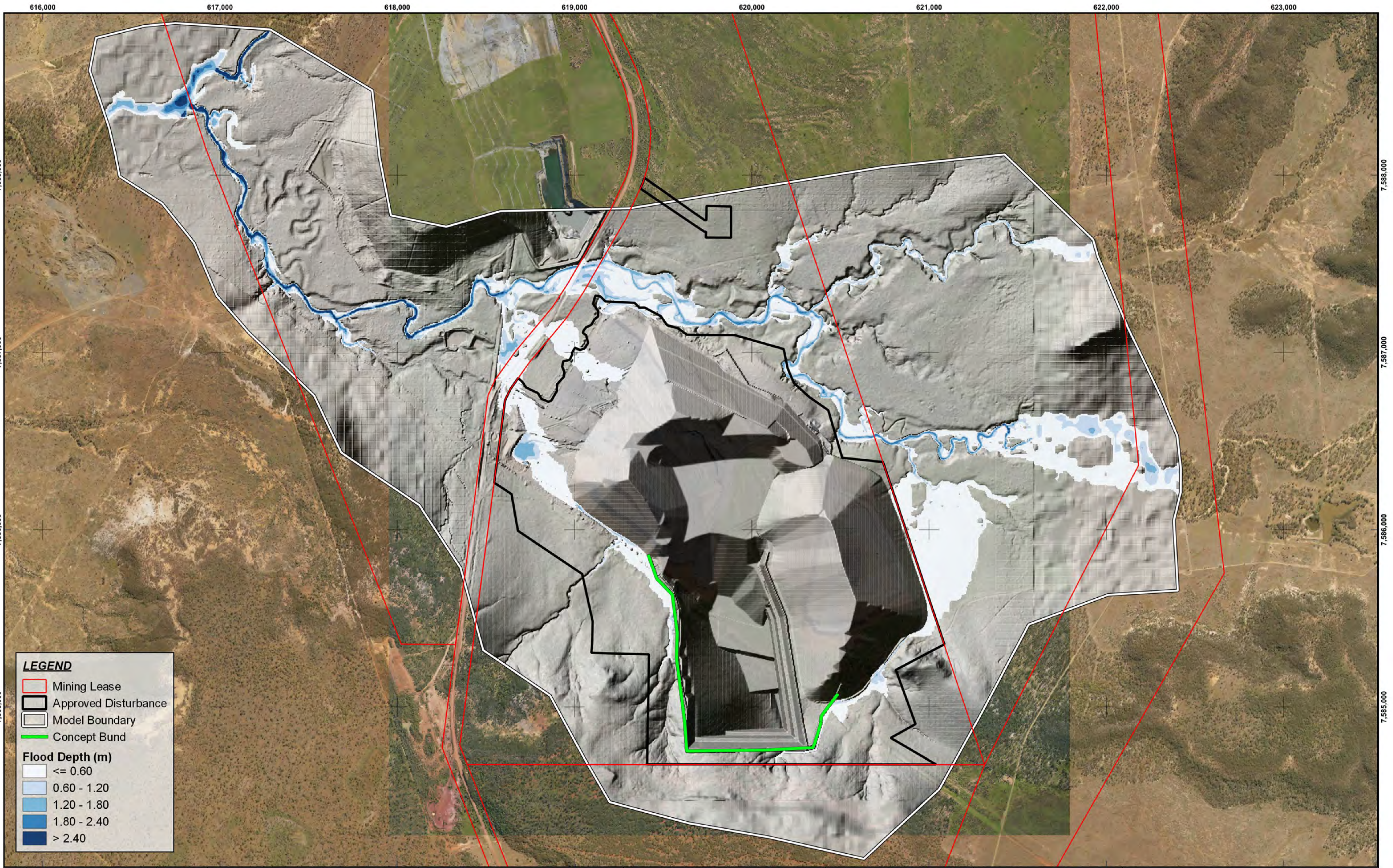

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Appendix A3 - 20% AEP Flood Depth

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref:
QC1015_005-FIG-Appendix A3

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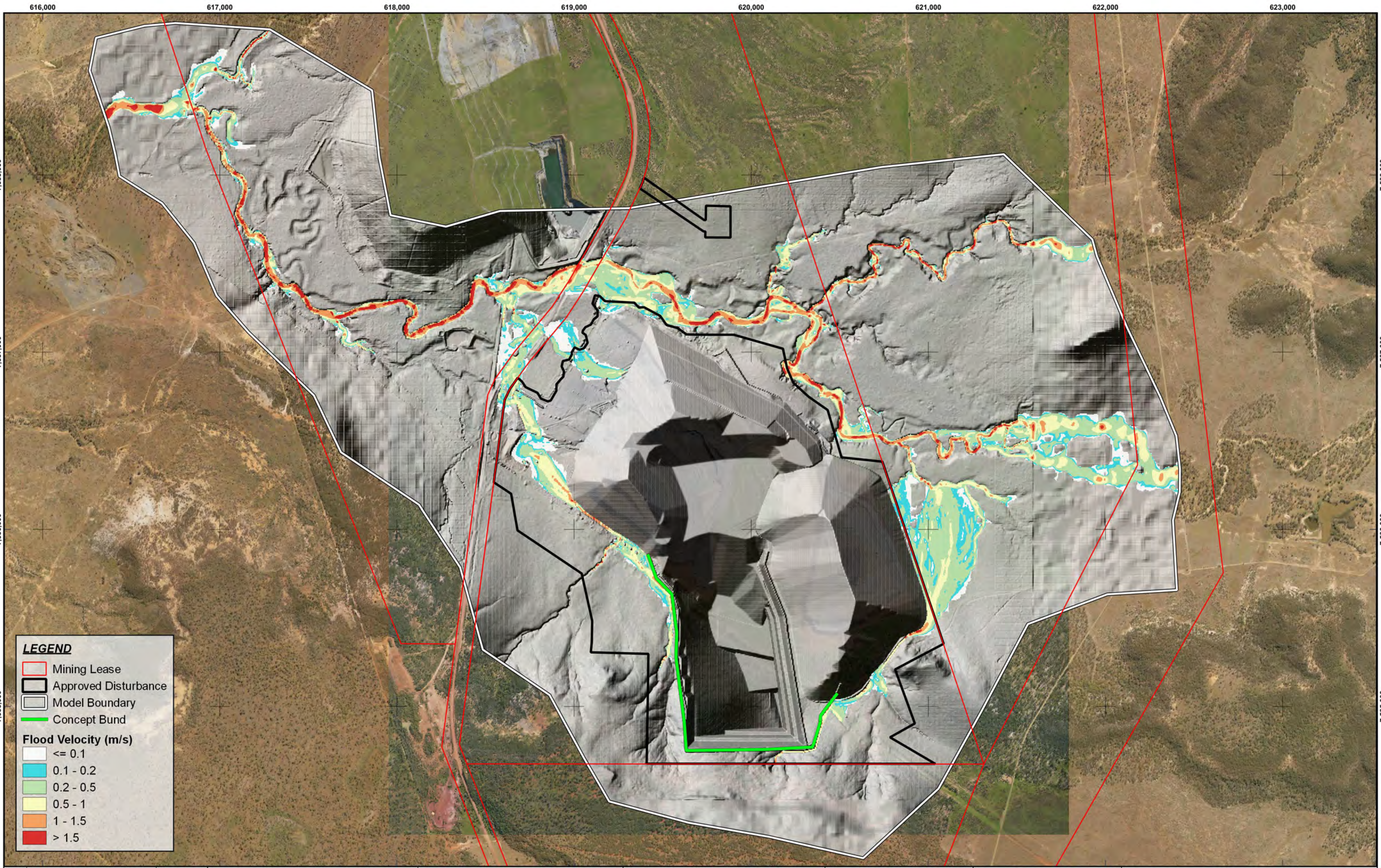

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Appendix A4 - 20% AEP Flood Velocity

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref.
QC1015_005-FIG-Appendix A4

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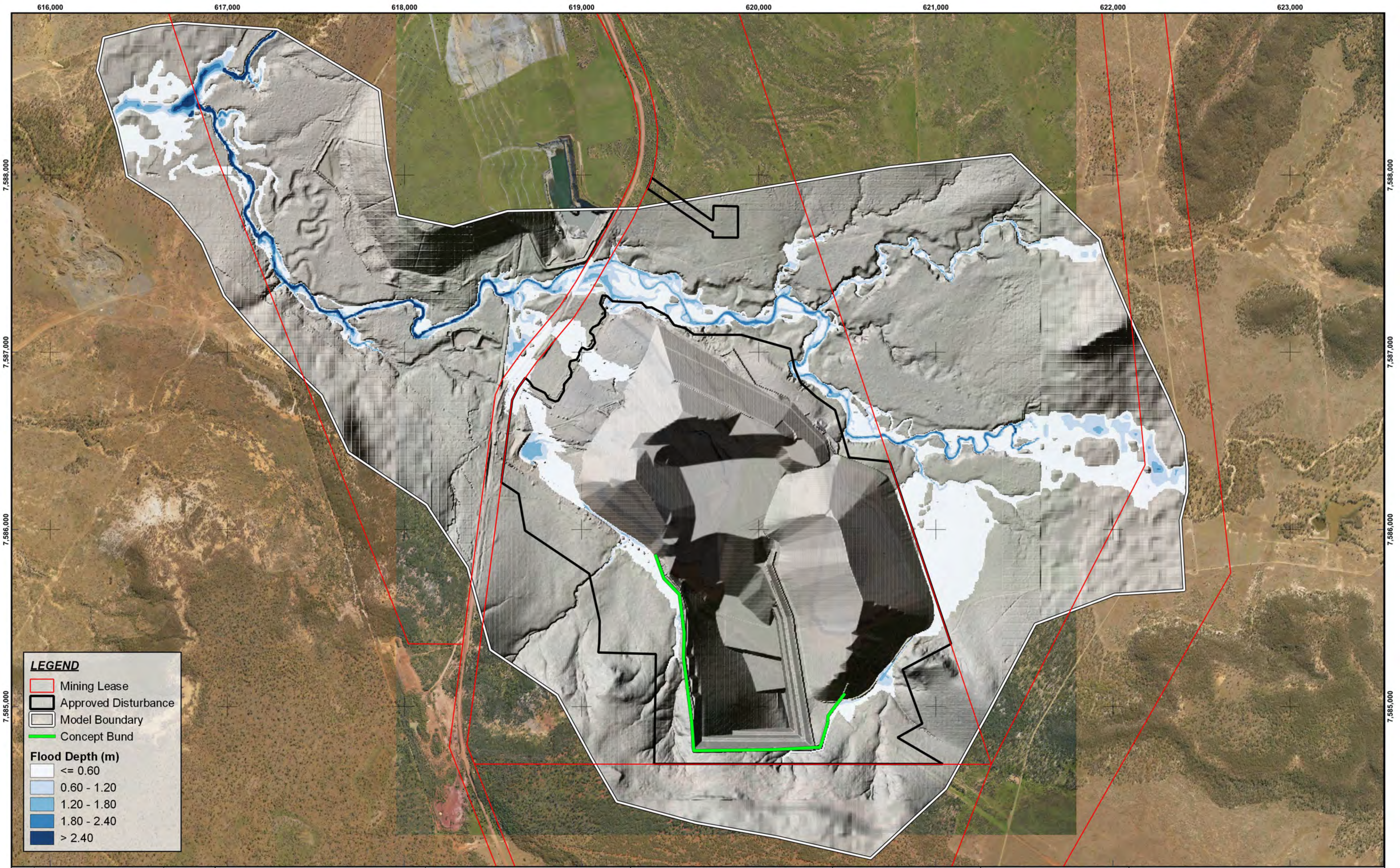

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Appendix A5 - 10% AEP Flood Depth

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref:
QC1015_005-FIG-Appendix A5

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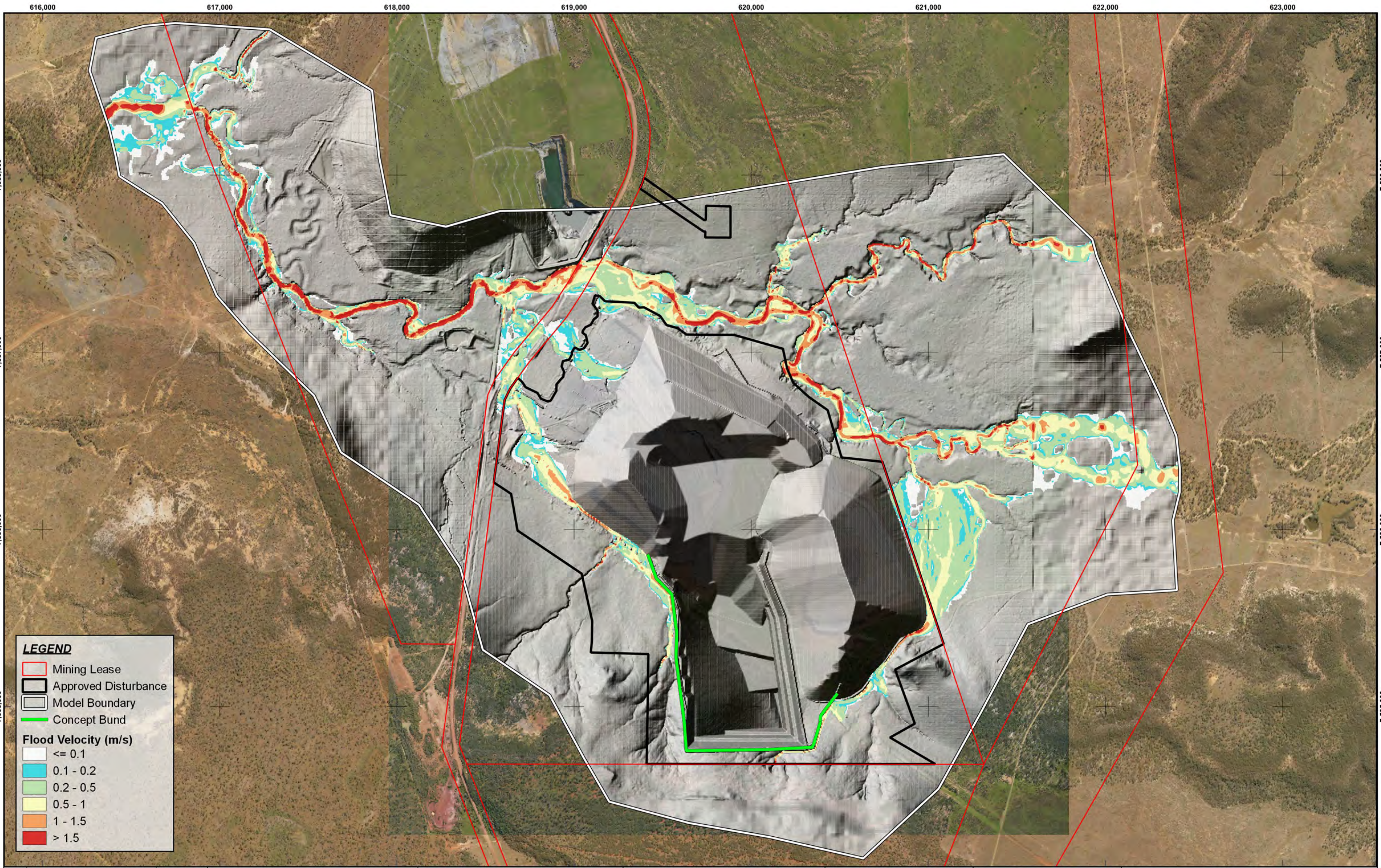

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Appendix A6 - 10% AEP Flood Velocity

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref:
QC1015_005-FIG-Appendix A6

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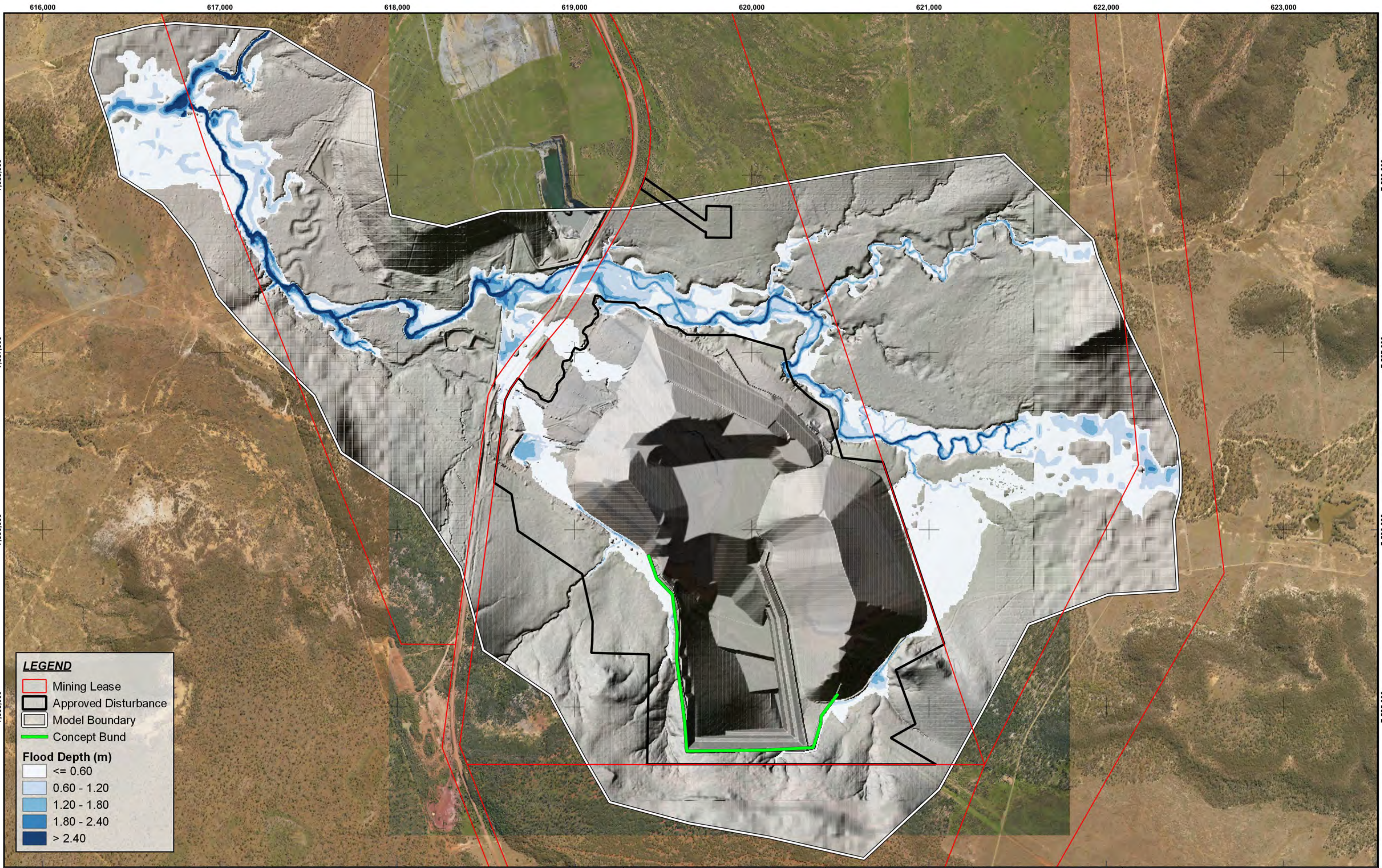

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Appendix A7 - 1% AEP Flood Depth

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref:
QC1015_005-FIG-Appendix A7

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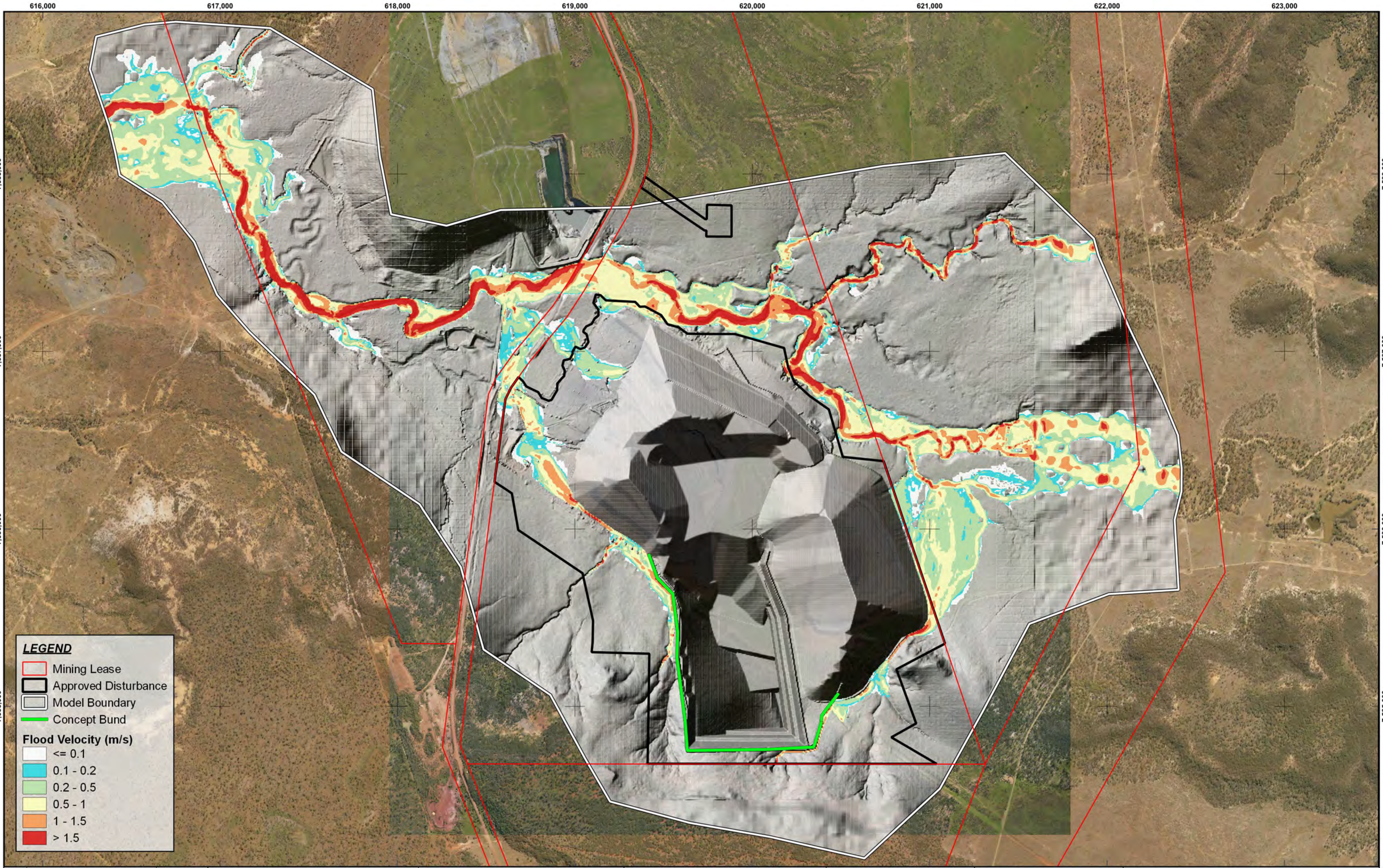

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Appendix A8 - 1% AEP Flood Velocity

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Dwg Ref:
QC1015_005-FIG-Appendix A8

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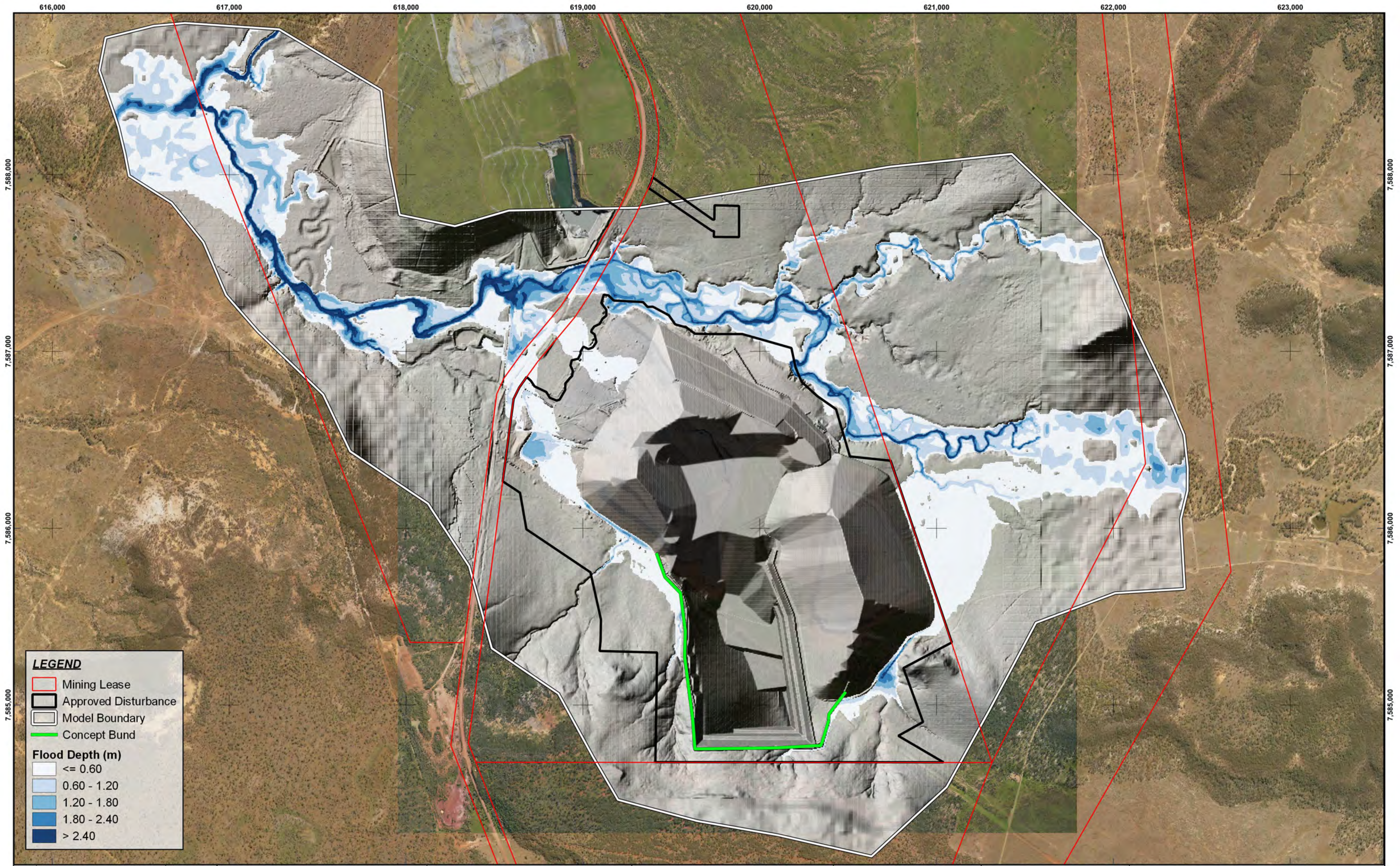

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0 0.4 0.8 km

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Appendix A9 - 0.1% AEP Flood Depth

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref:
QC1015_005-FIG-Appendix A9

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Appendix A10 - 0.1% AEP Flood Velocity

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Dwg Ref
QC1015_005-FIG-Appendix A10

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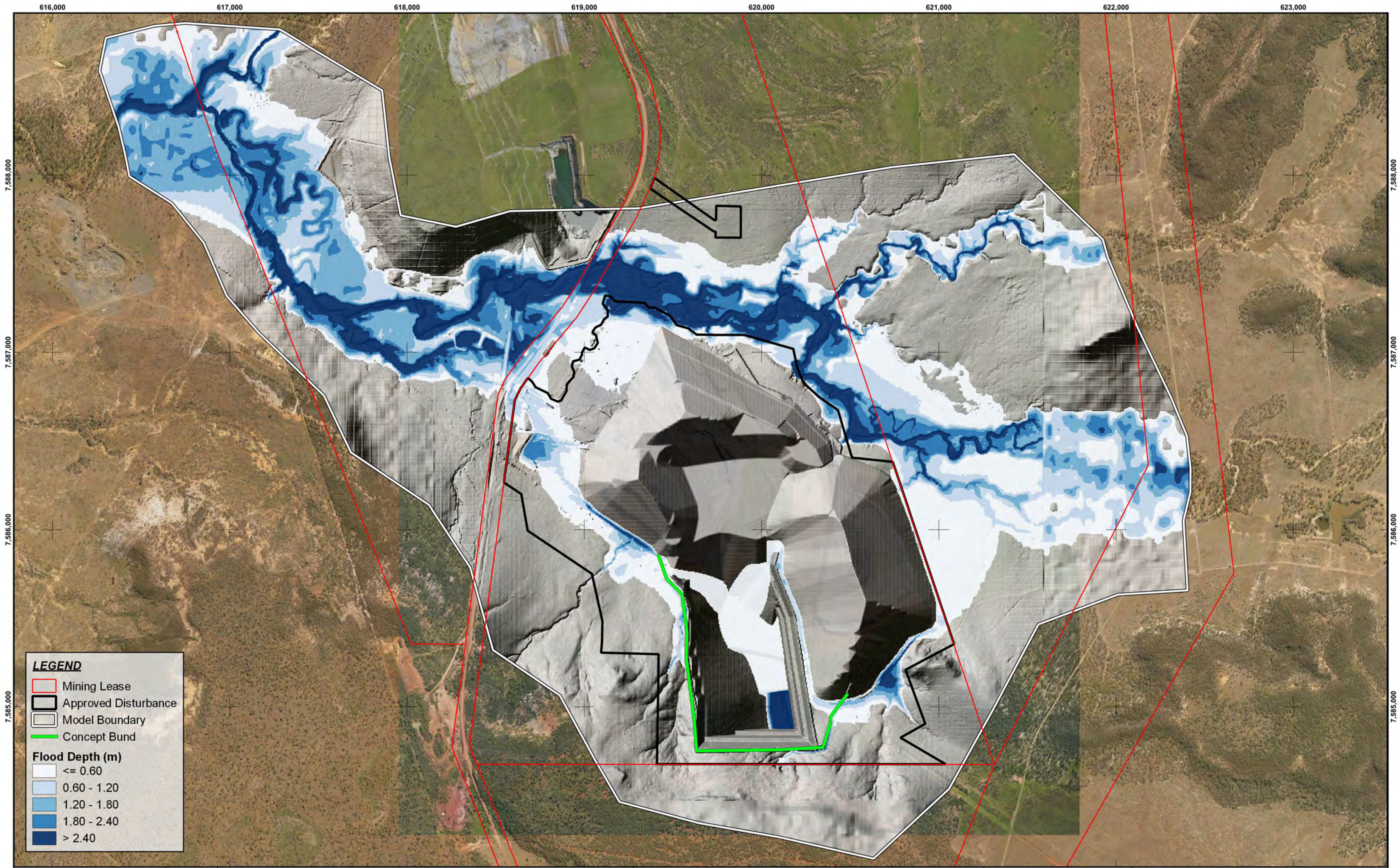

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0 0.4 0.8 km

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Appendix A11 - PMF Flood Depth

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref.
QC1015_005-FIG-Appendix A11

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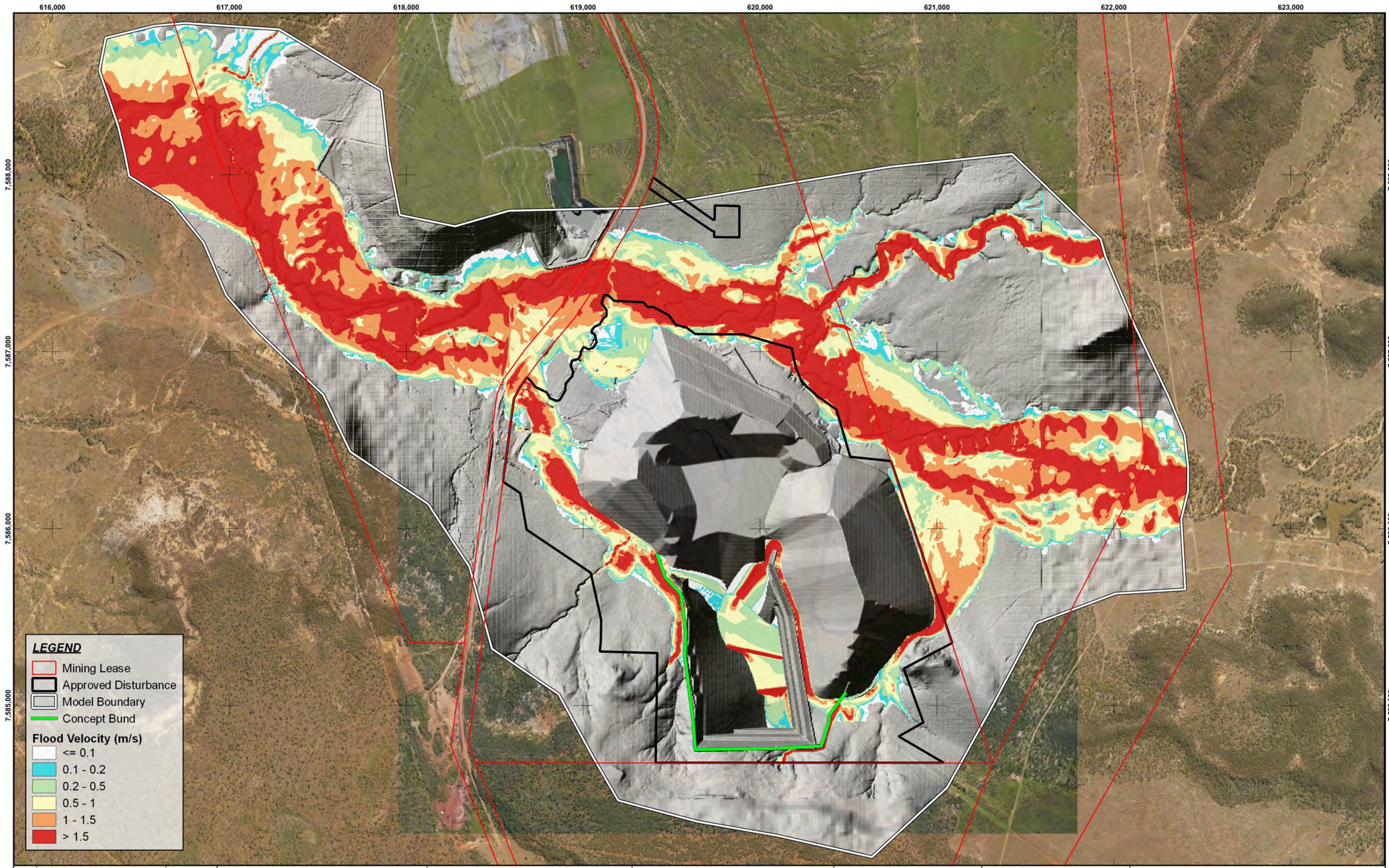

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N

0 0.4 0.8 km

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Appendix A12 - PMF Flood Velocity

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref.
QC1015_005-FIG-Appendix A12

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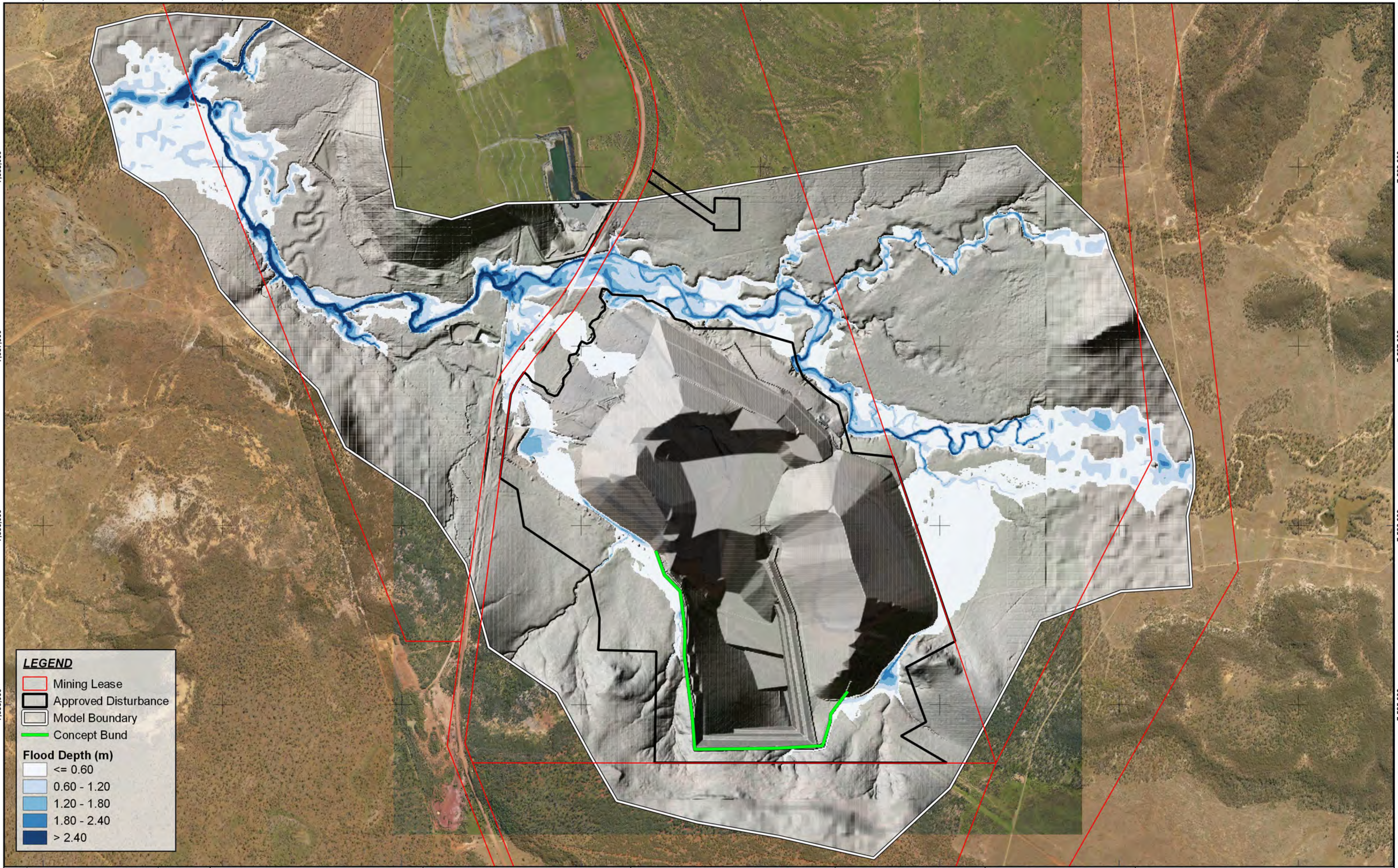
APPENDIX B: CLIMATE CHANGE RESUTLS



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APPROVED	SB	DATE	20-08-2023

NOTES: XXXXXXXXX

N

0 0.4 0.8 km

SCALE @ A3 - 1:19,000
GDA2020 / MGA zone 55

DATA SOURCE
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Appendix B1 - 1% AEP 2090 RCP 4.5 Flood Depth

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref.
QC1015_005-FIG-Appendix B13

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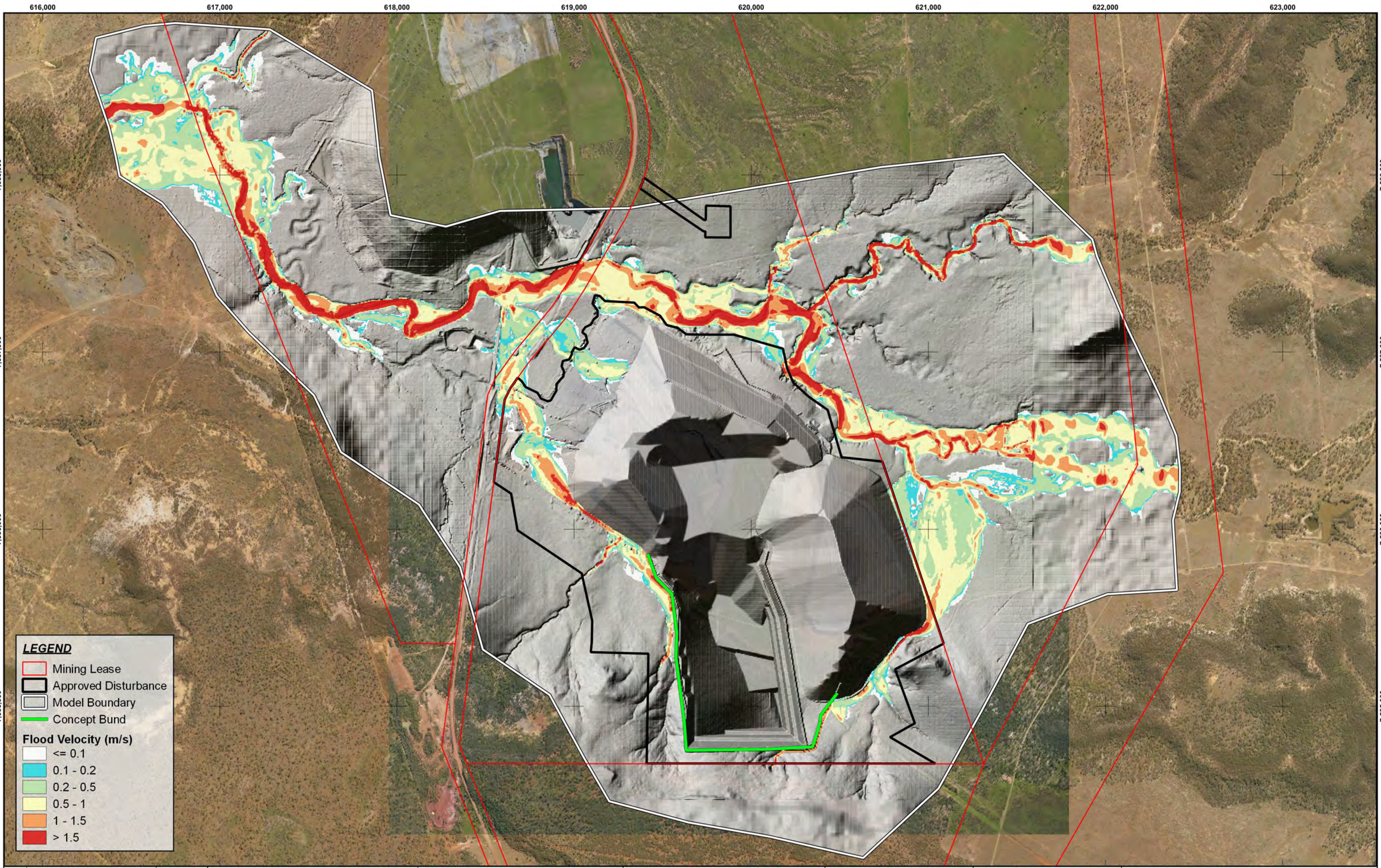

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N

0 0.4 0.8 km

SCALE @ A3 - 1:19,000
GDA2020 / MGA zone 55

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BOWEN COKING COAL LIMITED

Appendix B2 - 1% AEP 2090 RCP 4.5 Flood Velocity

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

QC1015_005-FIG-Appendix B14

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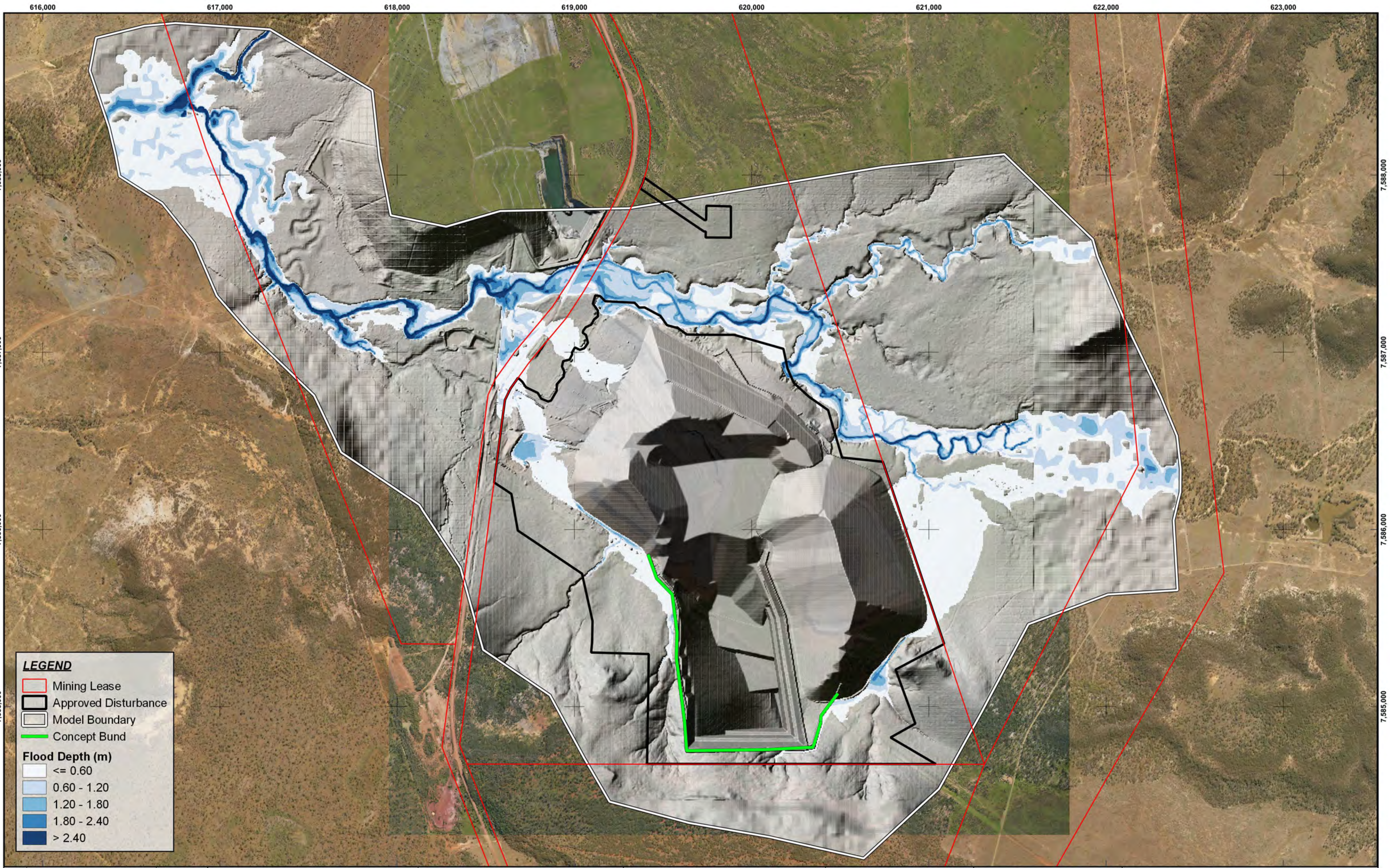

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1	Draft	18-08-2023

DRAWN	SW	CHECKED	CH
APPROVED	SB	DATE	20-08-2023

NOTES: XXXXXXXXX

N

0 0.4 0.8 km

SCALE @ A3 - 1:19,000
GDA2020 / MGA zone 55

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

ENGENY

BOWEN COKING COAL LIMITED

Appendix B3 - 1% AEP 2090 RCP 8.5 Flood Depth

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref:
QC1015_005-FIG-Appendix B15

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BOWEN COKING COAL LIMITED

Appendix B4 - 1% AEP 2090 RCP 8.5 Flood Velocity

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Dwg Ref:
QC1015_005-FIG-Appendix B16

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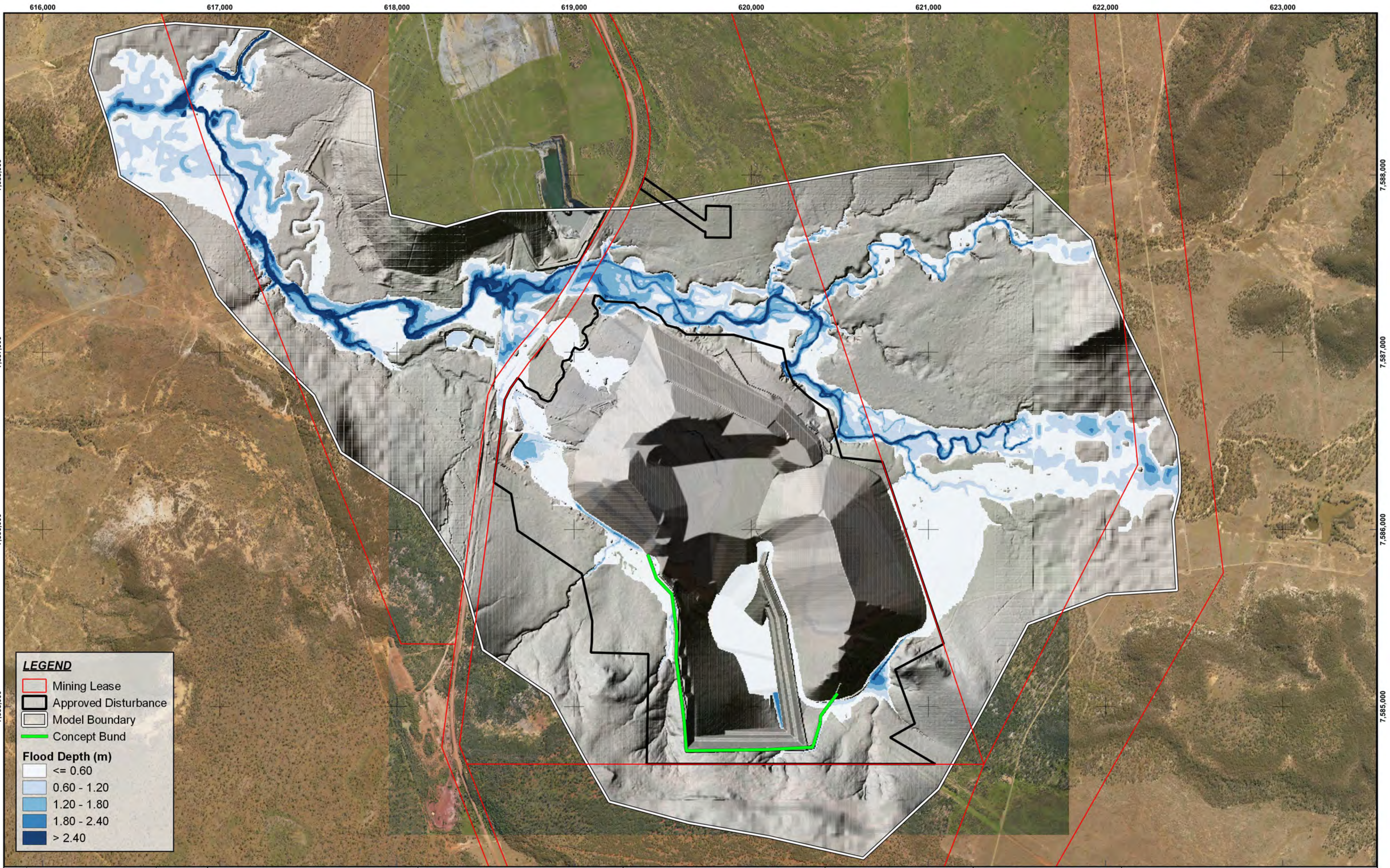

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SCALE @ A3 - 1:19,000
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Appendix B5 - 0.1% AEP 2090 RCP 4.5 Flood Depth

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref.
QC1015_005-FIG-Appendix B17

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BOWEN COKING COAL LIMITED

Appendix B6 - 0.1% AEP 2090 RCP 4.5 Flood Velocity

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Dwg Ref.
QC1015_005-FIG-Appendix B18

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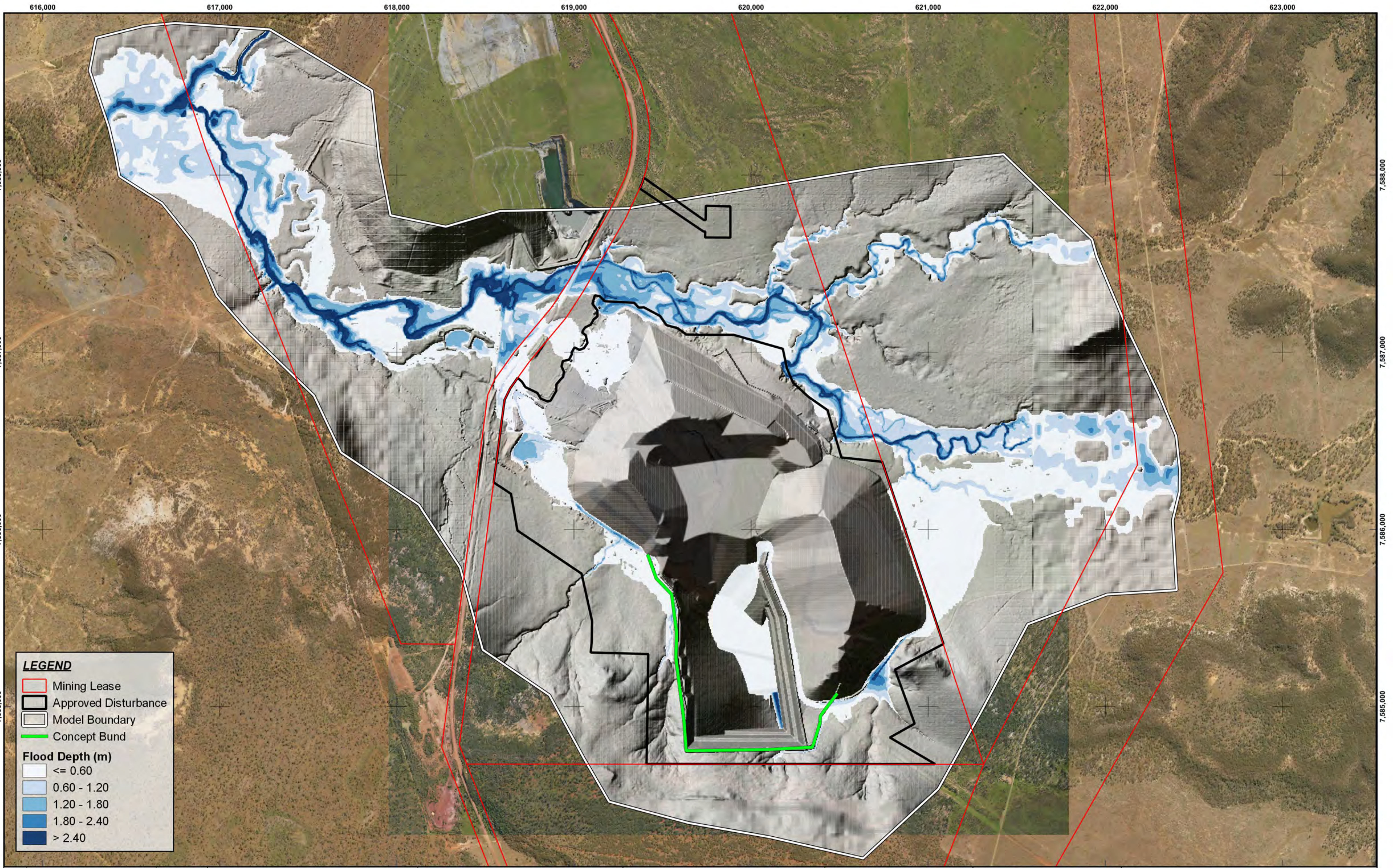

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APPROVED	SB	DATE	20-08-2023

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N

0 0.4 0.8 km

SCALE @ A3 - 1:19,000
GDA2020 / MGA zone 55

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Appendix B7 - 0.1% AEP 2090 RCP 8.5 Flood Depth

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref:
QC1015_005-FIG-Appendix B19

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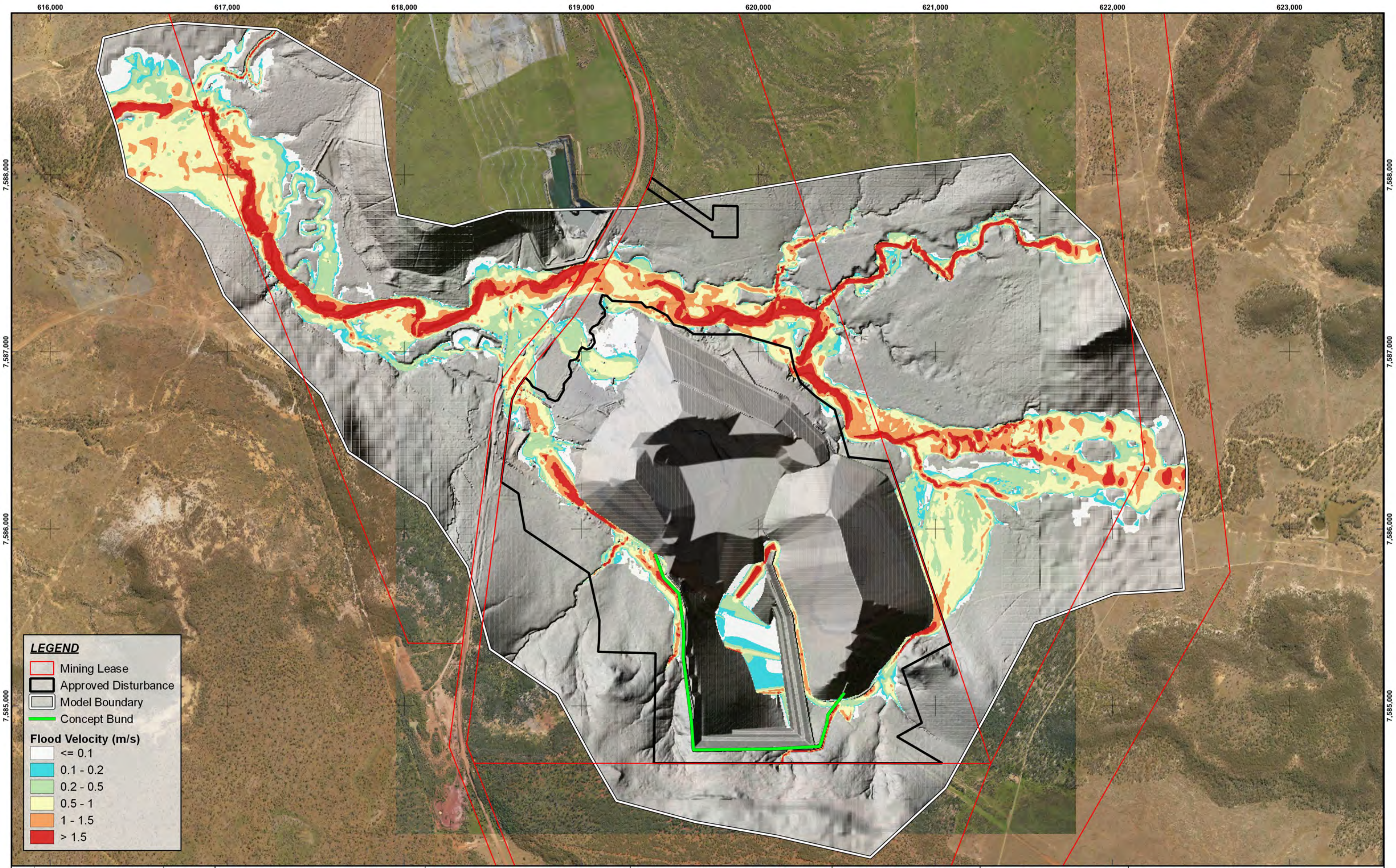

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APPROVED	SB	DATE	20-08-2023

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0 0.4 0.8 km

SCALE @ A3 - 1:19,000
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Appendix B8 - 0.1% AEP 2090 RCP 8.5 Flood Velocity

Bowen Coking Coal
BME PRCP
Final Landform Flood Model

Drg Ref:
QC1015_005-FIG-Appendix B20

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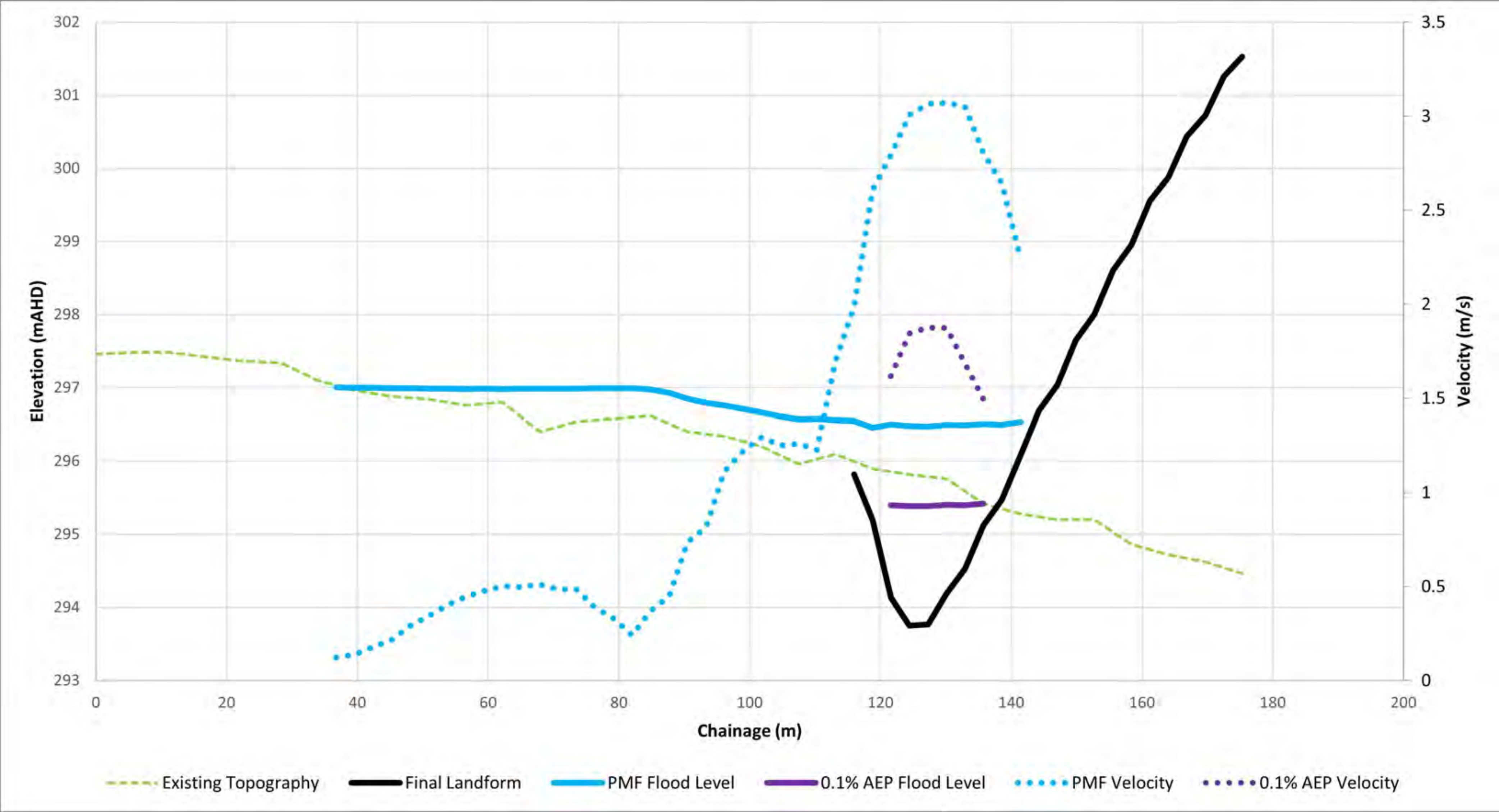
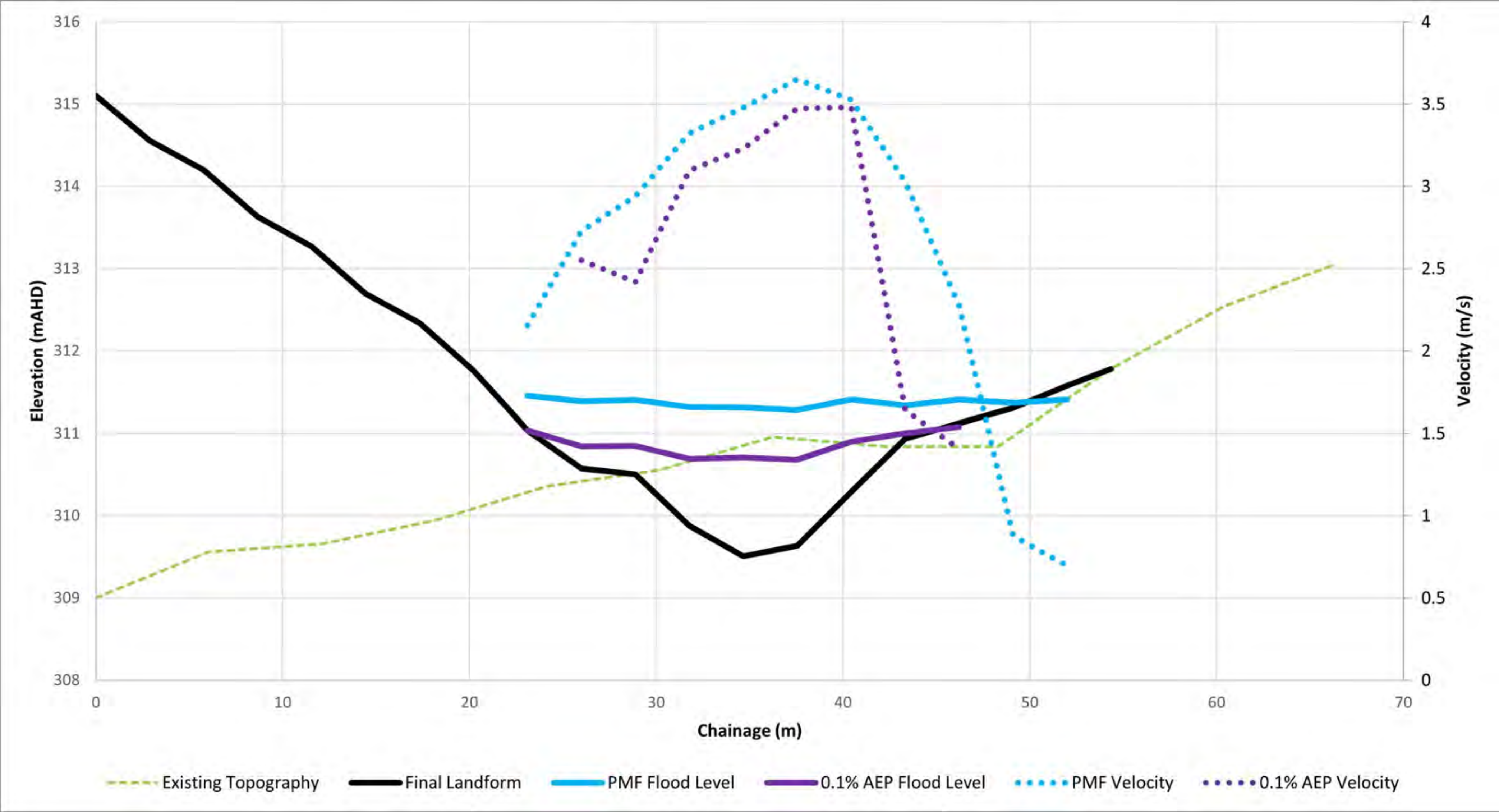
APPENDIX C: HYDRAULIC CROSS SECTION RESULTS



Elevation (mAHD)
Velocity (m/s)
Chainage (m)
Existing Topography
Final Landform
PMF Flood Level
0.1% AEP Flood Level
PMF Velocity
0.1% AEP Velocity



316
315
314
313
312
311
310
309
308
Elevation (mAHD)
4
3.5
3
2.5
2
1.5
1
0.5
0
Velocity (m/s)
0
10
20
30
40
50
60
70
Chainage (m)
Existing Topography
Final Landform
PMF Flood Level
0.1% AEP Flood Level
PMF Velocity
0.1% AEP Velocity

ENGENY

BOWEN COKING COAL

Broadmeadow East Mine PRCP

Final Void Water Balance Assessment

QC1015_004-REP-001-1

19 SEPTEMBER 2023

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
A	18/08/2023	Client Issue	Chris Harris	Samantha Breslin	Chris Harris	Samantha Breslin
1	19/09/2023	Client Issue	Chris Harris	Samantha Breslin	Chris Harris	Samantha Breslin
Signatures:						

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Appendices

Tables

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1. INTRODUCTION

Engeny Australia Pty Ltd (Engeny) has been engaged by Bowen Coking Coal (BCC) to undertake a final void water balance assessment for the Broadmeadow East (BME) Mine.

BME is an open cut coal mine located entirely within Mining Lease (ML) 70257. BCC purchased the 845-hectare (ha) ML 70257 from Peabody (Burton Coal) Pty Ltd, which led to the de-amalgamation from nearby tenures and associated Environmental Authority (EA) on 24 August 2020. BME is authorised under EA0002465, last issued on 2 February 2023.

BCC are preparing the transitional Progressive Rehabilitation and Closure Plan (PRCP) for BME. This report details the void hydrology water balance assessment for the final landform configuration of the site. It has been prepared to address relevant requirements of Section 3.6.3 'Voids' of the Department of Environment and Science (DES) PRCP Guideline (DES, April 2023) and to support development of the void closure plan for the site.

1.1 PRCP Guideline Section 3.6.3 Voids

This report addresses the following information requirements from the DES PRCP Guideline Section 3.6.3 'Voids':

- Void hydrology, addressing the long-term water balance and water level in the void, stratification and potential for overflow.
- Surface water elements of a water balance study including:
  - water storage and long-term water balance.
  - the sources of surface water within the mine catchment that are likely to influence the water quality in the void.
  - predicted water quality in the long-term including potential stratification.

2. SITE INFORMATION

BME is located 22 km north-east of Moranbah township and 120 km southwest of Mackay in the Queensland Bowen Basin (Figure 2.1).

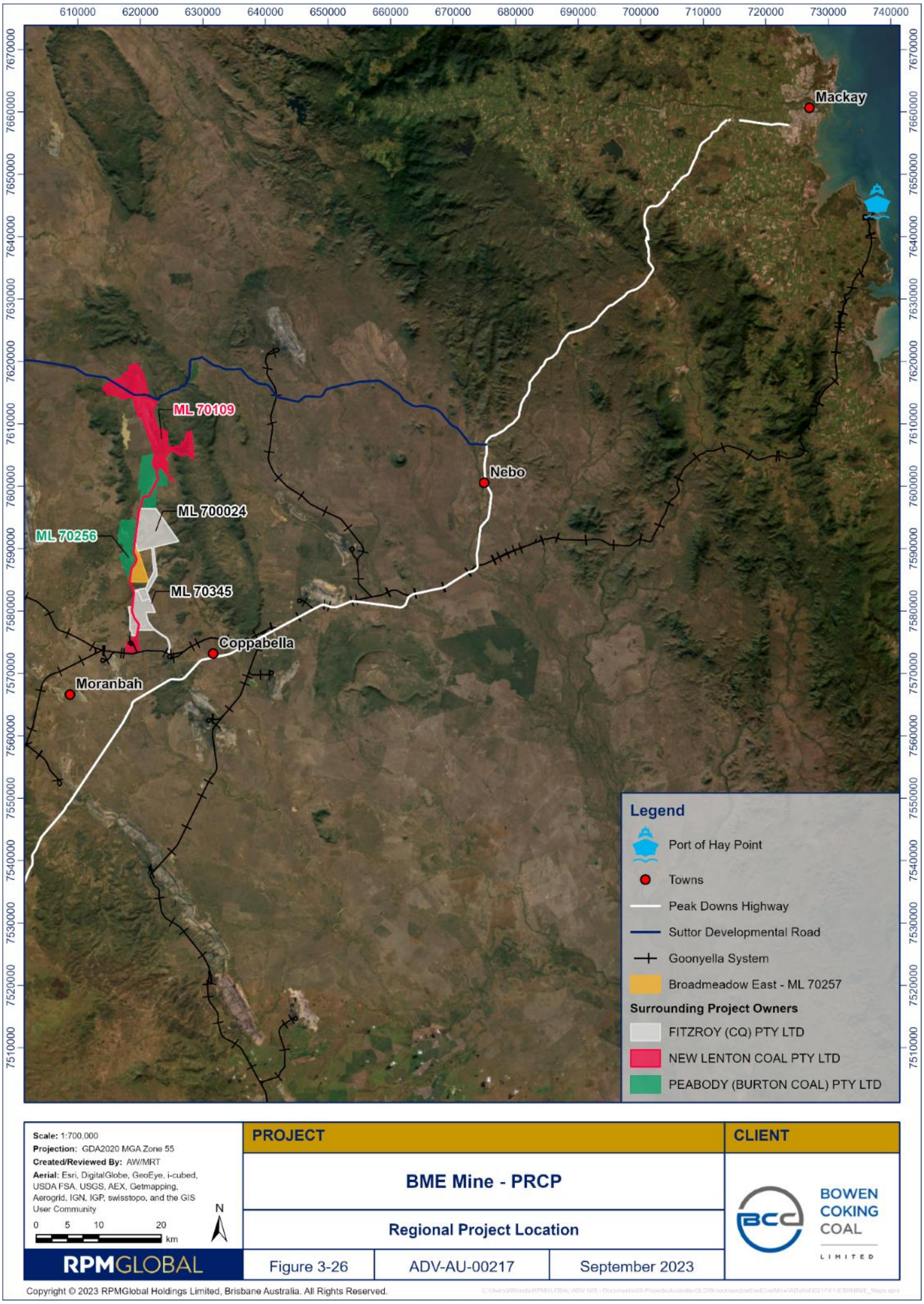

Figure 2.1: Site Location

2.1 Existing Site Topography and Water Features

Topographic data for BME includes detailed 5m Digital Terrain Model (DTM) within the ML boundary, and 25m Shuttle Radar Topography Mission (SRTM) DEM for the topography outside of the ML. The existing topography consists of several unnamed and named waterways, ranging from minor to non-perennial waterways. All waterways are ephemeral in nature. The largest of the waterways that traverse the ML is Hat Creek, which flows directly adjacent of the northern extent of the mine footprint. Hat Creek is a minor tributary of Teviot Brook, which it joins with downstream of the site boundary. Refer to Figure 2.2 for further information.

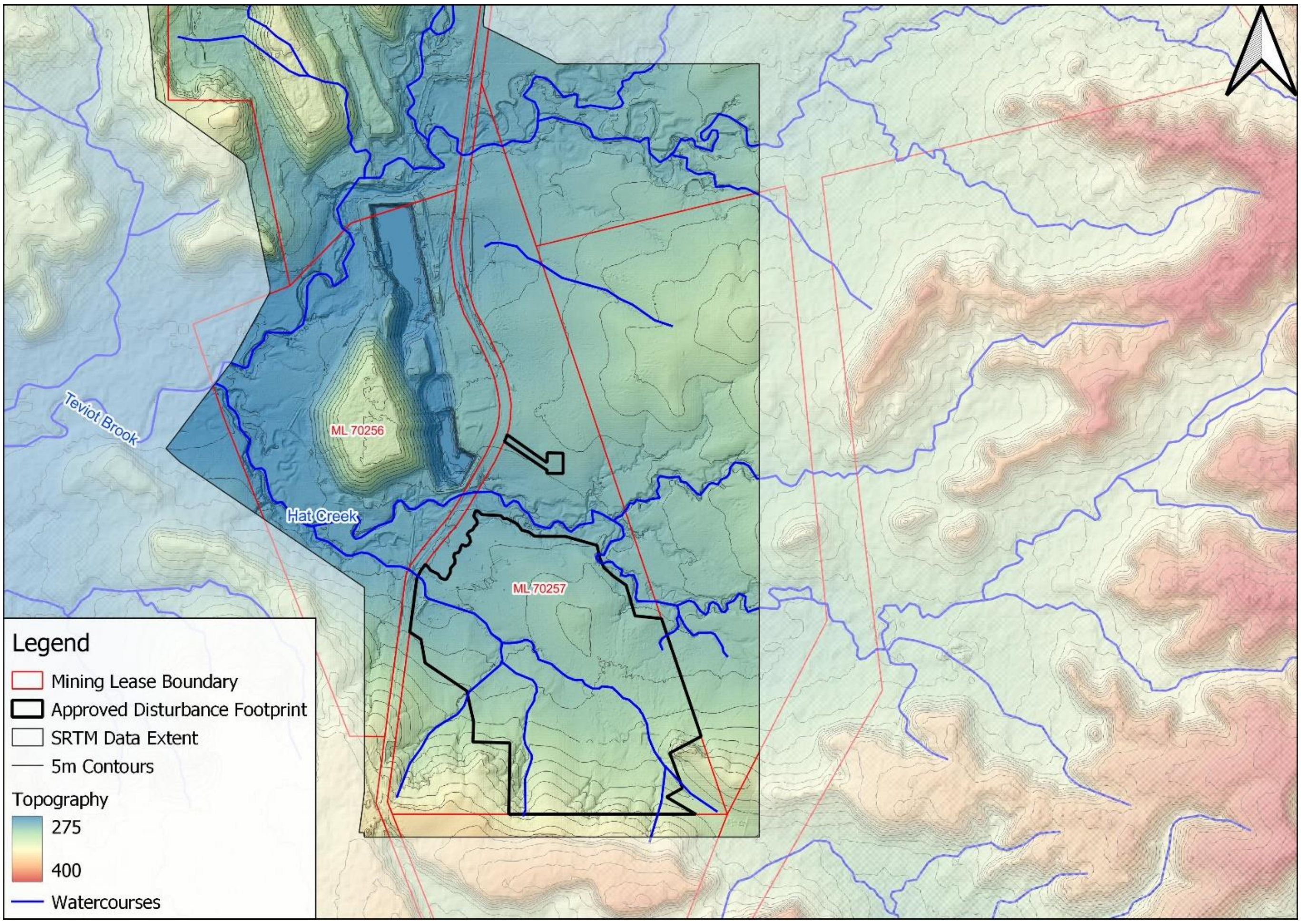

Figure 2.2: Existing Site Topography

2.2 Final Landform

Mining at BME has begun at the northern portion of the proposed pit area and is progressively occurring along the resource in a southerly direction. The northern portion of the pit will be partially backfilled and kept available for use as bulk water storage during operation. Prior to closure, the bulk water storage will be filled to the surrounding topography at the end of mine life when no longer required.

The initial overburden has been placed in the two Out of Pit Dumps that will be constructed over the operational period prior to rehabilitation works. Overburden will also be placed within the pit as mining progressively moves south, leaving one final void in the southern extent of the pit (South Pit). For the purposes of this assessment, all disturbed areas are assumed to be rehabilitated at closure excluding the area below the elevation of 250 RL (mAHD) to the base of pit at 225 RL (mAHD) within South Pit, due to this area being modelled below the longer-term water level based on WBM results (Refer to Appendix A). Drainage and pit protection infrastructure (e.g. bund/road) along the South pit highwall is proposed to remain post-closure after rehabilitation as a small access track for post closure monitoring and maintenance and will continue to direct clean surface water around South Pit towards Hat Creek to the North. This ensures that clean water runoff from the natural catchment area (~35ha) that would otherwise report into the pit, is directed towards Hat Creek and retained in the receiving environment catchment. The final landform for BME is shown in Figure 2.3.

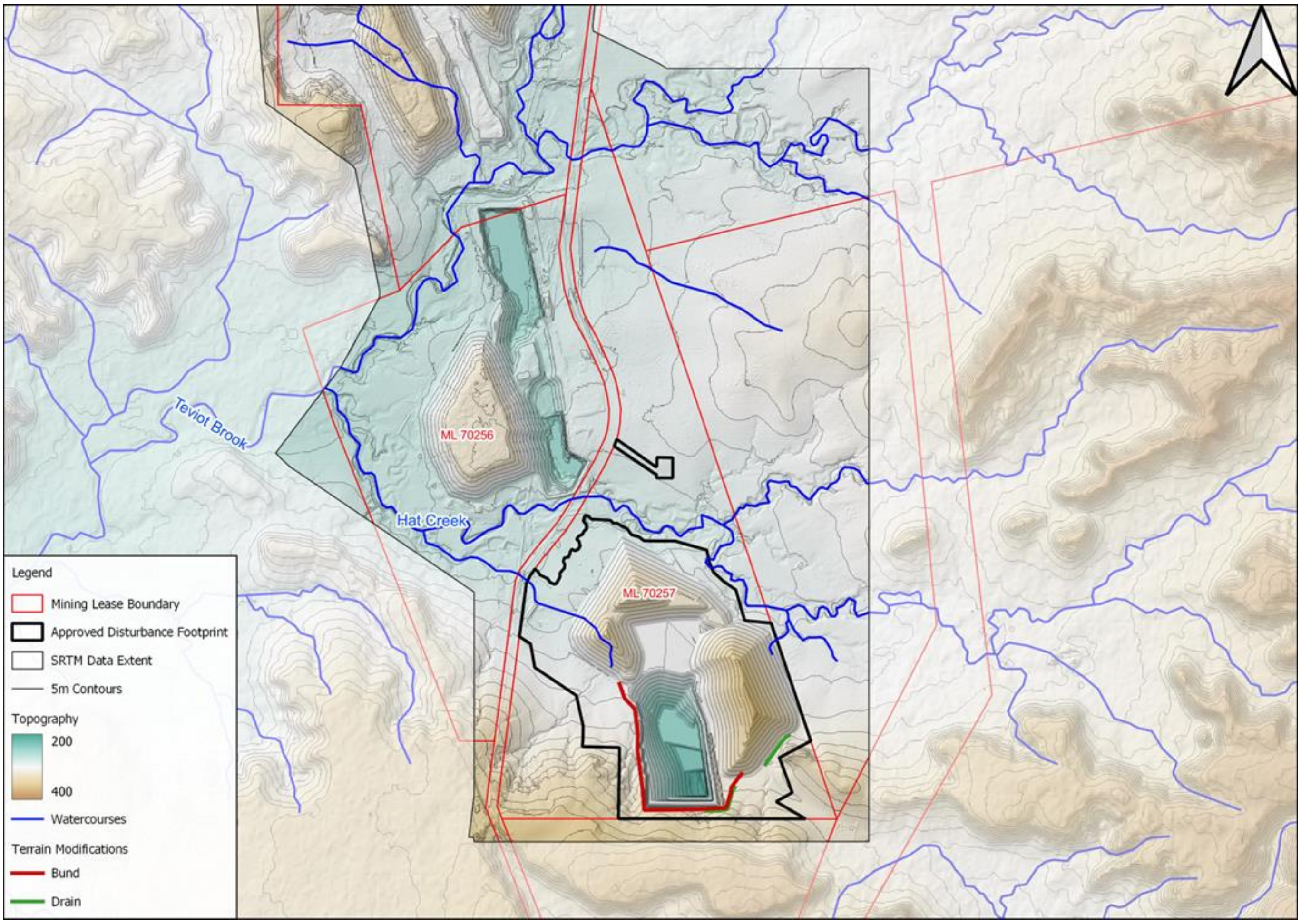

Figure 2.3: Final Landform

3. FINAL VOID HYDROLOGY ASSESSMENT

As discussed in Section 2, BME's final landform includes one open pit void in closure (South Pit). BME spoil stockpiles and the southern void low wall will be rehabilitated and regraded such that where practicable surface water drains away from South Pit. Based on the existing natural topography and proposed final landform, the southern void will have a surface water catchment of 167Ha. For the purpose of this hydrology assessment, all spoil dumps and disturbed areas are assumed to be successfully rehabilitated in the closure scenario and the southern void rehabilitated down to 250 RL (mAHD). No other water retaining pits/voids are proposed at closure of BME.

A void water balance model (WBM) has been developed using GoldSim modelling software. This model has been designed to represent the final landform configuration for the site to assess the behaviour of South Pit in the long-term post-closure. The void water balance model is used to calculate water volume and levels as well as quality (salinity) using a mass balance approach. The model uses the Australian Water Balance Model (AWBM) to estimate rainfall runoff from local climate data inputs.

The water balance model is based on local rainfall runoff modelling and does not incorporate flood interactions. As assessment of rehabilitation flood susceptibility is documented separately in the following study, QC1015_005-REP-0 "*Broadmeadow East Final Landform Flood Assessment*".

The key indicators of the hydrological behaviour of the void for this assessment include:

- Void lake equilibrium level - The equilibrium level is defined as the forecast median level (50th percentile) after the initial filling period. This is considered to be the level at which the void lake is most likely to sit with periodic fluctuations above and below. Equilibrium level is relatively stable in the long-term following the initial filling period.
- Void lake equilibrium volume – The equilibrium volume is defined as the volume corresponding to equilibrium level.
- Void lake maximum level – The maximum level is defined as the highest void lake level forecast during the simulation.
- Void lake filling time – The void filling time is defined as the initial period of filling of the void after cessation of mining until the lake reaches its equilibrium volume.
- Ponded area at equilibrium – Equilibrium level is determined by the balance between lake inflows (primarily catchment runoff) and outflows (primarily evaporation). The evaporation is governed by the ponded area of the lake based on the adopted storage curve.
- Void lake water quality (Electrical Conductivity (EC)) 300 years after cessation of operations – Void lake salinity has been reported at the end of the simulation to indicate the general trend of EC over time. The concentration of salts is forecast to increase beyond the simulation period as there are negligible outflows of the salts from the residual void.
- Residual void outcome - The void equilibrium and maximum level results have been compared with the regional groundwater levels supplied by the groundwater technical consultants to determine whether the void is likely to act as a groundwater 'sink' or a 'source'.
  - Sink - A groundwater 'sink' refers to a void which has modelled equilibrium and/or maximum levels lower than the regional groundwater level. The hydraulic gradient generated by this change in levels would result in groundwater ingress to the pit.
  - Source - A groundwater 'source' refers to a void which has a net outflow of water from the void lake into the surrounding geology (generally identified by a water level above the regional groundwater level) where such outflow is not into the low-wall backfill material. In these cases, the hydraulic gradient could result in water within the pit seeping into groundwater systems.

3.1 Final Void Water Balance Model Development

The model development is summarised in Table 3.1 and the final void storage characteristics are shown in Figure 3.1

TABLE 3.1: FINAL VOID WATER BALANCE MODEL DEVELOPMENT

Input	Description
Final Void Inflows	
Catchment Runoff	Catchment runoff inflow to South Pit void is estimated as 167 ha (31ha final void surface area and 136 ha rehabilitated land). The associated AWBM and water quality parameters are provided in Table 3.4 and Table 3.5 .
Direct Rainfall	Direct rainfall on the final void surface area is calculated from daily rainfall applied to the surface area of the final void which is dynamically calculated each daily timestep using the stage storage relationship for South Pit as shown in Figure 3.1
Groundwater Inflows	Groundwater inflows calculated based on the final void level groundwater inflow relationship shown in Figure 3.2. The adopted groundwater inflow salinity is discussed in Section 3.1.4.
Final Void Outflows	
Evaporation	Evaporation from the final void lake surface area is calculated from daily Moreton's Lake Evaporation time series extracted from the SILO Data Drill at the BME location. Average annual Moreton's Lake evaporation at the final void waterbody is 1,806 mm/year (refer to Figure 3.3). For the purpose of modelling long term void lake behaviour, it is noted that evaporation rates from water bodies reduce with increasing water salinity. This reduction relationship varies depending upon the specific chemical composition of the water body. A site-specific relationship is not currently available for the BCM and consequently, Morton's method for adjusting evaporation rates has been adopted as presented in Hydrological Recipes: Estimation Technique in Australian Hydrology (1996). Evaporation reduction factor = $\frac{1}{\left[1+\frac{Salinity\ (ppm)}{10^\wedge 6}\right]}$ where, salinity (ppm) = Total Dissolved Solids (TDS) (mg/L).

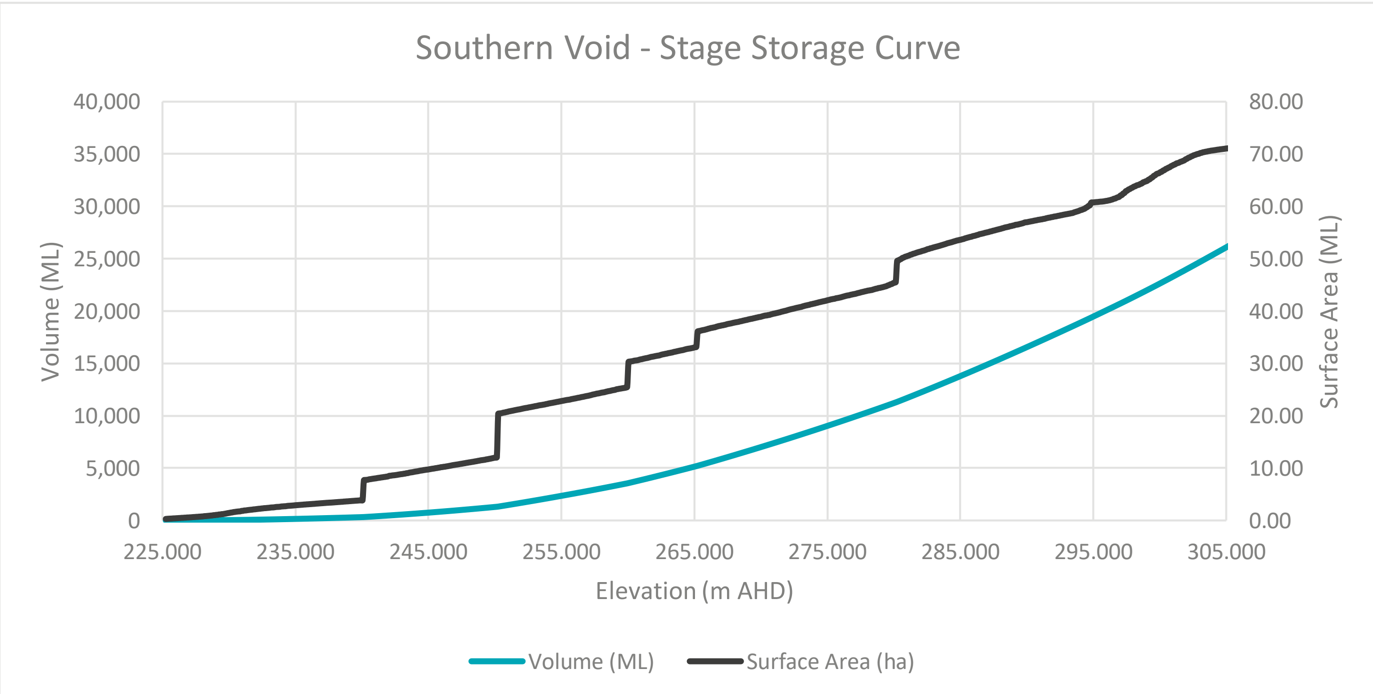

Figure 3.1: South Pit - Final Void Storage Characteristics

3.1.1 Model Key Assumptions

A number of key assumptions were made during the model development process and are summarized in Table 3.2.

TABLE 3.2: KEY WBM ASSUMPTIONS

Input Parameter	Assumption, Justification and Data Source
Groundwater Inflow to Pits	Groundwater ingress rate delineated in Figure 3.2. Based on updated numerical groundwater assessment undertaken by KCB in 2023.
Groundwater Quality	1000 mg/L (1500 µS/cm). Based on groundwater quality sampling data of Rangal Coal Measures (Bowen Coking Coal, 2021).
Southern Void Closure Starting Water Level	It is assumed that to allow for the removal / backfilling and rehabilitation of operational water retaining structures (i.e. Mine Water Dam and North Bulk Water Storage), total stored water at start of closure will be pumped to the Southern void. The Southern Void starting water level is therefore assumed to conservatively start at 380ML based on potential maximum storage on-site.

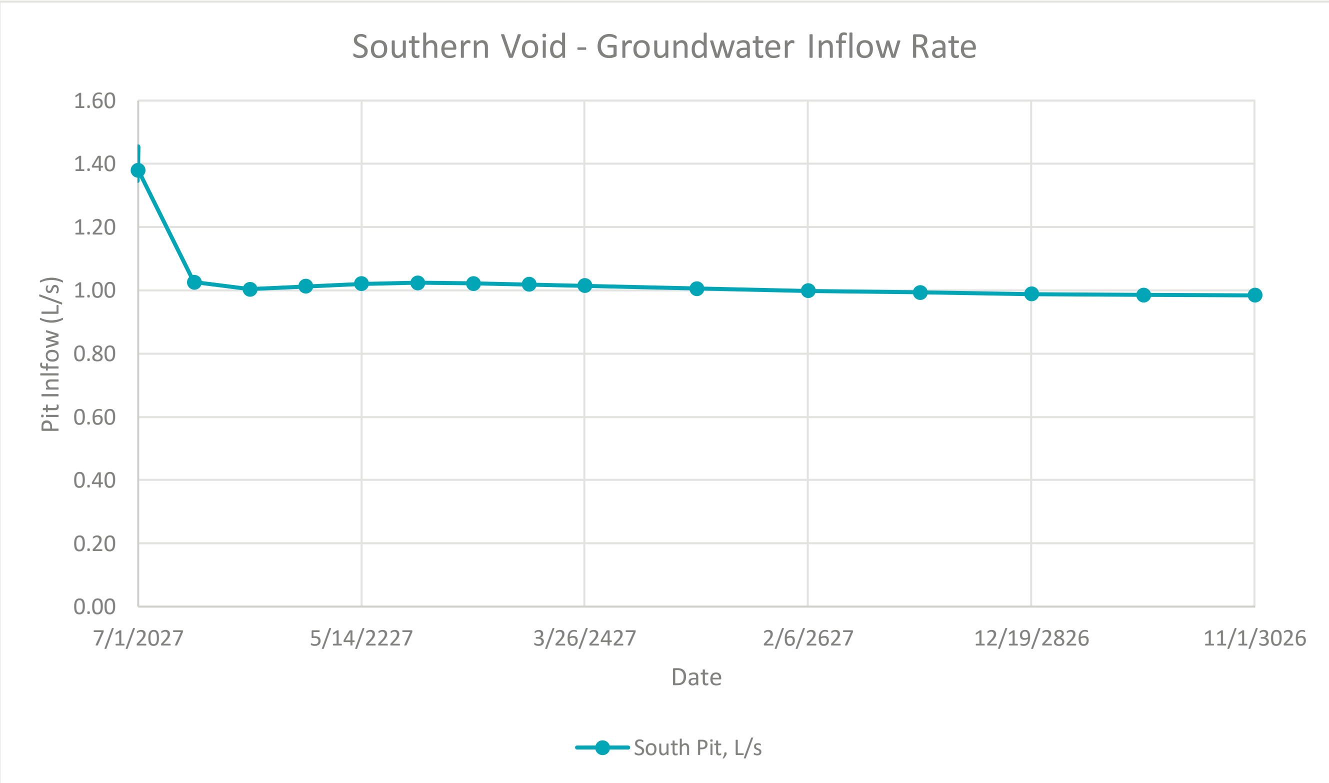

Figure 3.2: Southern Void Groundwater Ingress Curve (KCB, 2023)

3.1.2 Climate Inputs

Climate data for the system was derived from the SILO rainfall database facility hosted by the Department of Science, Information Technology and Innovation (DSITI). An approximate 300-year dataset was used to allow a continuous simulation of scenarios. Monthly average rainfall, evapotranspiration (Morton's Potential Evapotranspiration) and lake evaporation (Morton's Lake Evaporation) from the SILO climate dataset for BME are summarised in Table 3.3.

TABLE 3.3: MONTHLY AVERAGE CLIMATE DATA USED FOR WBM

Month	Rainfall (mm)	Lake Evaporation (mm)	Evapotranspiration (mm)
January	114	196	234
February	102	165	193
March	70	165	197
April	31	131	165
May	26	102	137
June	30	82	114
July	21	93	128
August	19	121	159
September	15	154	197
October	30	190	240
November	51	200	247
December	84	209	254
Total	**592**	**1,806**	**2,265**

3.1.3 Catchment Runoff

Catchment runoff has been simulated using the AWBM. The model represents the catchment using three surface stores to simulate partial areas of runoff. The water balance of each surface store is calculated independently of the others. The model calculates the water balance of each partial area at daily time steps. At each time step, rainfall is added to each of the three surface stores and evapotranspiration is subtracted from each store. If the value of water in the store exceeds the capacity of the store, the excess water becomes runoff. Part of this runoff becomes recharge of the base flow store if there is a base flow component to the stream flow. A schematic representation of the AWBM model is provided in Figure 3.3 .

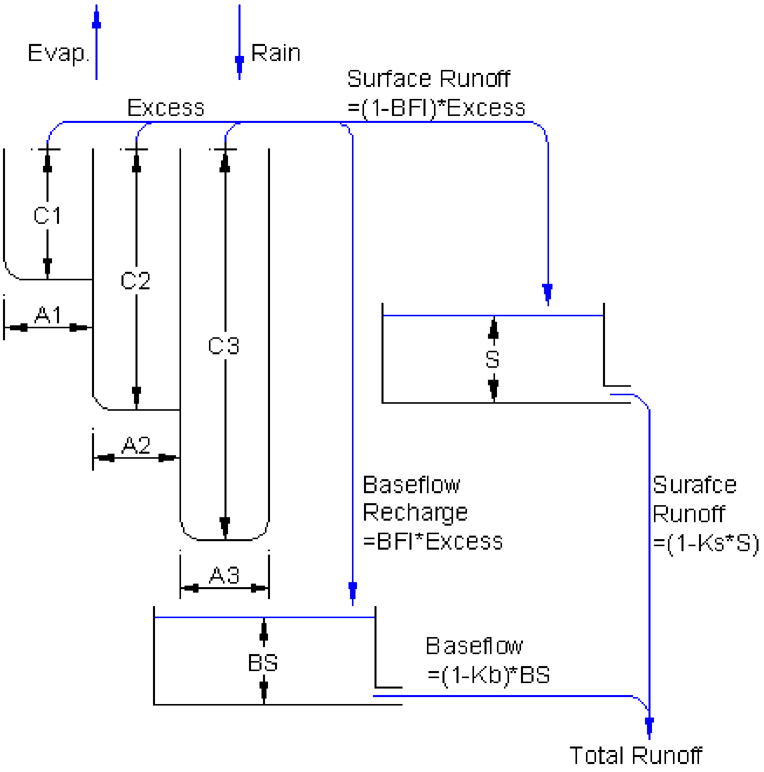

Figure 3.3: AWBM Schematic

The adopted AWBM parameters are shown in Table 3.4. In the absence of calibrated AWBM parameters for BME the adopted AWBM parameters are consistent with the parameters used and developed as part of a calibrated water balance model for the Bowen Basin which was calibrated to the Isaac River. The inability to calibrate project specific AWBM parameters is due to insufficient local stream flow gauging (the mine only commenced operations in 2022). Therefore, the adopted parameters are consequently considered the most representative for water balance modelling for the site.

In accordance with the EA permit, streamflow and water quality monitoring of Hat Creek will be conducted during operations upstream and downstream of site release points. This site-specific streamflow data will allow for future calibration and refinement of the adopted AWBM parameters as part of future water balance model updates under the BME Water Management Plan during operations.

TABLE 3.4: AWBM PARAMETERS

Parameter	Natural	Waste Dump/Active Rehabilitation	Mining Pit/Hardstand	Rehabilitated Spoil
A1	0.134	0.134	0.134	0.134
A2	0.433	0.433	0.433	0.433
A3	0.433	0.433	0.433	0.433
C1 (mm)	10	10	5	12
C2 (mm)	55	50	20	71
C3 (mm)	115	120	40	141
BFI	0.45	0.35	0	0.35
Kb	0.6	0.6	0.6	0.6
Ks	0.2	0.1	0.1	0.1
Average annual runoff coefficient	13.49%	13.88%	25.62%	11.27%

3.1.4 Catchment Runoff Water Quality

The WBM includes a contaminant transport model to simulate water quality (salinity) within site storages. Salinity generation rates for the assigned land use types are summarised in Table 3.5.

Runoff entering South Pit final void is assumed to be completely mixed with any current storage. This does not account for the potential stratification of water quality within the void where partial mixing with different layers may occur. Assuming complete mixing of the void lake provides an average salinity in the final void over the simulation period (Refer also to Section 3.2 below).

TABLE 3.5: SALINITY GENERATION RATES FOR LAND USE TYPES

Land Use Type	Salinity (µS/cm)	Source of Data
Natural	178	80th percentile water quality results of the tributaries of Burton Gorge Dam (Teviot Creek and Sandy Creek) were averaged and were adopted for the purpose of the WBM (Peabody, February 2019)
Mining Pit Floor	1,370	BME geochemical testing undertaken in February 2021
Rehabilitation Spoil	425	In absence of project specific water quality data for rehabilitated landuse, the parameter has been sourced from the regional model that has been calibrated to the Isaac River

3.2 Final Void Stratification

Stratification involves multiple layers of differing water quality based on density differences in the final void. The likelihood of stratification is mainly attributed to the depth of the final void water body. Some stratification is likely to occur in South Pit due to the average water depth within the pit of 29.1m, however stratification is likely to be negligible in terms of risk due to the average salinity level results from the water balance observed as already potentially hyper saline without further considering the likelihood of stratification turn over.

3.3 Final Void Water Balance Model Outcomes

The final void water balance model was simulated for 300 years based on historical climate data with 131 realizations. The key model outputs for the South Pit are summarised below and in Table 3.7. A graphical representation of the forecast void lake level, volume and salinity for South Pit is provided in Appendix A, B and C respectively.

- South Pit - Void Lake Levels.
  - The modelling results show no modelled overflows from the residual South void.
  - The void lake levels are forecast to fluctuate over time as a result of prevailing climate conditions. The approximate South Pit equilibrium level of 249 m AHD is 39.8 m below the pre-mining groundwater level of 288.8 m AHD.
  - The maximum South void lake level 254.1 m AHD is 45.9 m below the pre-mining groundwater level, and therefore, based on the modelled results it is expected the South Pit Void will have no potential net outflows to the local geology and regional groundwater and is considered a “groundwater sink”.
  - The void lake level generally rises over the initial 25 years following the cessation of mining.
- South Pit - Void Lake Quality.
  - The salinity of South Pit void is forecast to continue to increase over time due to the ongoing concentration of salt due to evaporation with no outflows of salt from the system. WBM Southern void water quality results forecast pit water salinity over 10,000µS/cm within 70 years of closure.

TABLE 3.7: SOUTH PIT WBM RESULTS SUMMARY

Residual Void	Catchment Area (ha)	Void Equilibrium Level (m AHD)	Maximum Water Level (m AHD)	Void Spilling Elevation Level (m AHD)	Pre-mining Groundwater Level (m AHD)[1.]	Void Equilibrium Volume (ML)	Ponded area at Equilibrium (ha)	Void Equilibrium EC at 300 years (µS/cm)	Maximum Void EC (µS/cm)[2.]	Initial Void Filling Period (Years)
South Pit	167	249.0	254.1	300	288.8	1,130	10.7	45,548	130,000	25

1. Pre-mining ground water level for South Void from MBBE0001

2 The maximum EC represents the fluctuations in water quality due to evaporation resulting in concentration of salt in the pit lake during dry periods.

4. QUALIFICATIONS

(a) In preparing this document, including all relevant calculation and modelling, Engeny Australia Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

(b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

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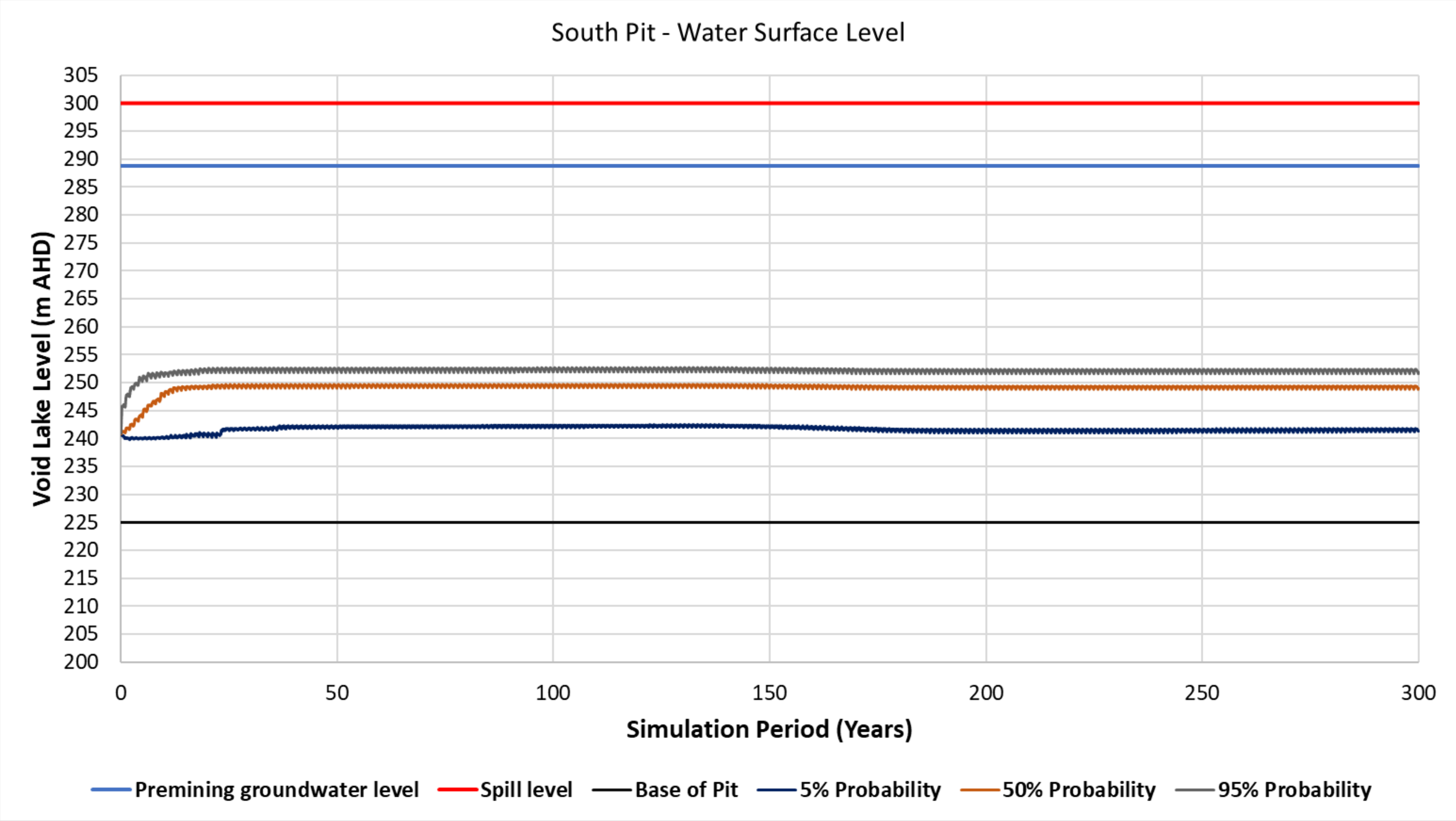
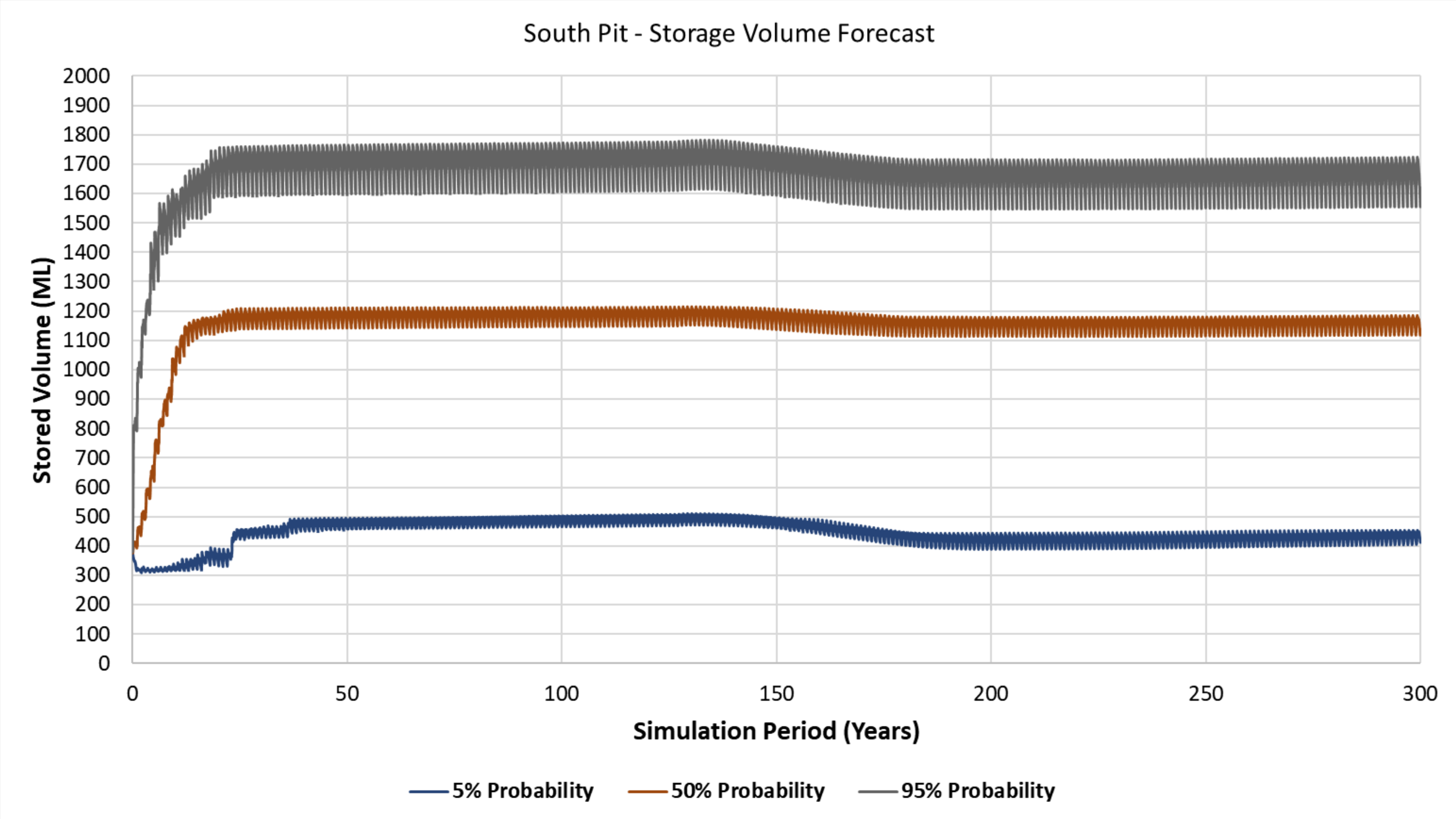
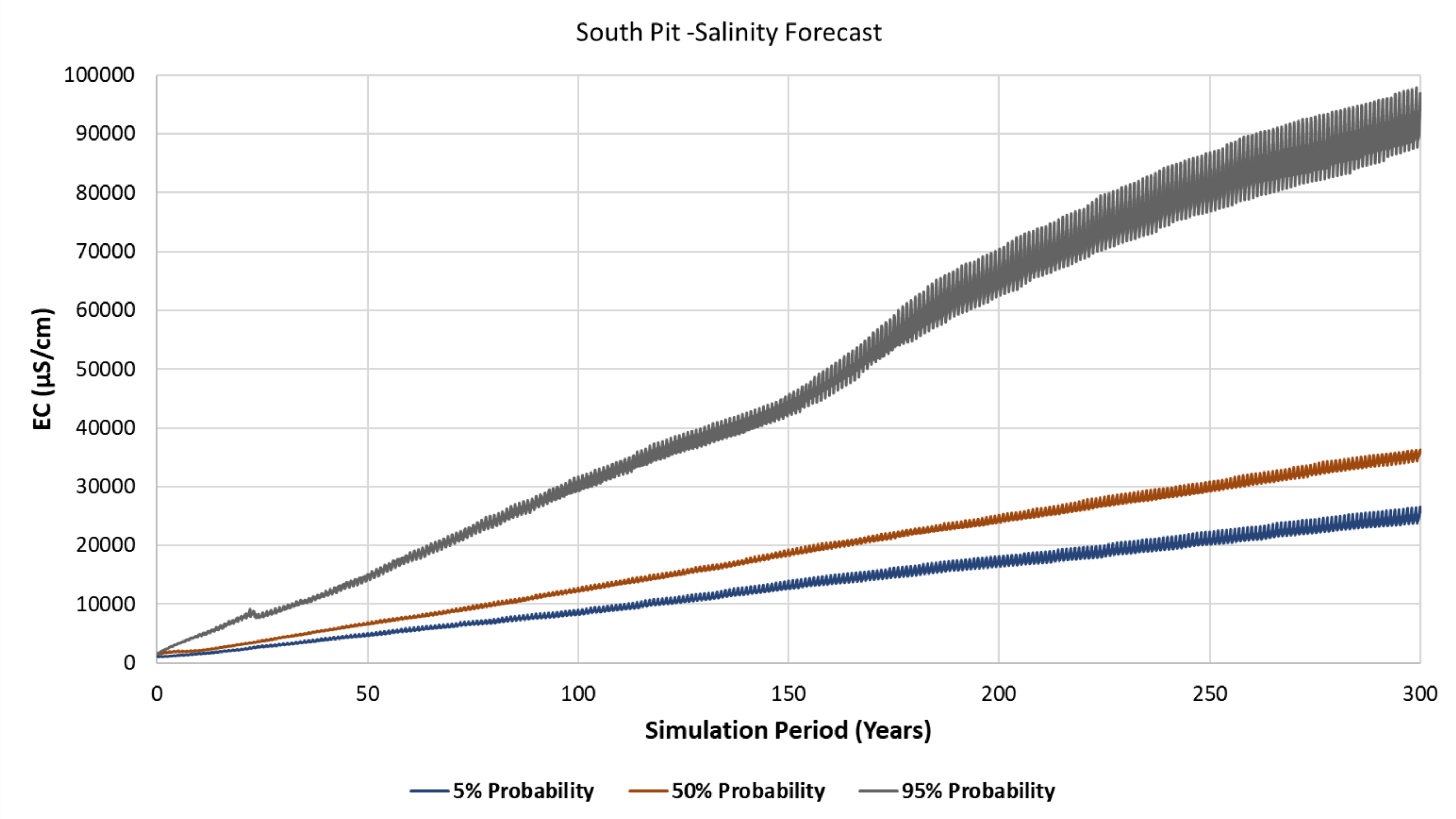
APPENDIX A: SOUTH PIT – WBM WATER SURFACE LEVEL RESULTS


South Pit - Water Surface Level
305
300
295
290
285
280
275
270
265
260
255
250
245
240
235
230
225
220
215
210
205
200
Void Lake Level (m AHD)
0
50
100
150
200
250
300
Simulation Period (Years)
Premining groundwater level
Spill level
Base of Pit
5% Probability
50% Probability
95% Probability

APPENDIX B: SOUTH PIT – WBM STORAGE VOLUME RESULTS


South Pit - Storage Volume Forecast
Stored Volume (ML)
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
50
100
150
200
250
300
Simulation Period (Years)
5% Probability
50% Probability
95% Probability

APPENDIX C: SOUTH PIT – WBM SALINTY RESULTS


South Pit -Salinity Forecast
EC (µS/cm)
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
0
50
100
150
200
250
300
Simulation Period (Years)
5% Probability
50% Probability
95% Probability

TECHNICAL REPORT

Mine material assessment and landform stability assessment

Prepared for: Coking Coal One Pty Ltd

MINE WASTE AND
WATER MANAGEMENT

Date of issue: 4.05.2022

TECHNICAL REPORT

Mine material assessment and landform stability assessment

Prepared for: Coking Coal One Pty Ltd

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Limitations and disclaimer:

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Glossary of Terms and Acronyms

ALS	Australian Laboratory Services Pty Ltd
ABA	Acid Base Account, an evaluation of the balance between acid generation and acid neutralisation processes. Generally, determines the MPA and the inherent ANC, as defined below, and is commonly used in assessing the potential for AMD associated with mining.
AMD	Acid, saline, and metalliferous drainage caused by exposure of sulfide minerals in mine waste materials to oxygen and water.
ANC	Acid neutralising capacity of a sample as kg H_2SO_4 per tonne of sample. Commonly referred to as the buffering capacity.
ANC:MPA Ratio	Ratio of the acid neutralising capacity and maximum potential acidity of a sample. Used to assess the risk of a sample generating acid conditions.
CHPP	Coal Handling and Preparation Plan
Coal roof	100 cm above the immediate coal roof
Immediate coal roof	0 to 30 cm above the economic coal
Immediate coal floor	0 to 30 cm below the economic coal
Coal floor	100 cm below the immediate coal floor
Coal rejects	Coal rejects are produced when coal is washed in a coal handling and process plant (CHPP). The rejects can include breaker rejects (> 300 mm PSD) to fine rejects (>0.075 mm).
Coal tailings	< 0.075 mm PSD
Reject coal	Non-economic coal
Coal partings	Thin sedimentary layers of noncoal rock within a coal bed
Plies	Physical subdivisions of coal
Dispersive	Dispersive soil and rock materials are structurally unstable and disperse into basic particles such as sand, silt and clay in water. When a dispersive soil is wet, the basic structure has a tendency to collapse, whereas when it is dry it is prone to surface sealing and crusting.
EA	Environmental Authority
EC	Electrical conductivity, expressed as µS/cm, is a measure of electrical conductance.
ESP	Exchangeable sodium percentage provides a measure of the sodicity of a materials and propensity to erode.
Interburden	The waste rock material found between coal seams.
KLC test	Kinetic leach column tests are procedures used to measure the geochemical/ weathering behaviour of a sample of mine material over time.
LoR	Limit of reporting – equivalent to a detection limit
ML	Mining Lease
MPA	Maximum Potential Acidity calculated by multiplying the total sulfur content of a sample by 30.625 (stoichiometric factor) and expressed as kg H_2SO_4 per tonne.

NAF	Non-acid forming. Geochemical classification criterion for a sample that will not generate acid conditions.
NAF-Barren	Non-acid forming and barren of sulfur (ie. less than or equal to 0.07% sulfur). Geochemical classification criterion for a sample that will not generate acid conditions.
NAPP	Net acid producing potential expressed as kg H_2SO_4 per tonne. NAPP is the balance between the capacity of a sample to generate acidity (MPA) minus its capacity to neutralise acidity (ANC).
NMD	Neutral mine drainage typically caused by exposure of sulfide minerals in mine waste materials to oxygen and water and then neutralisation by gangue minerals. Typically characterised by neutral pH and elevated concentrations of salts, sulfate, and metals.
NPR	Neutralising potential ratio – ANC:MPA ratio.
OOPD	Out of Pit Dump
Overburden	Material that overlays a coal resource and must be removed to mine the coal.
PAF	Potentially acid forming. Geochemical classification criterion for a sample that has the potential to generate acid conditions.
pH	Measure of the hydrogen ion (H+) activity in a sample solution, expressed in pH units.
PRCP	Progressive Rehabilitation and Closure Plan
PSD	Particle size distribution of a sample material measured by hydrometer.
ROM	Run of Mine
Topsoil	O and A soil horizons. Upper layer of soil (0.0 - 0.5m). Highest concentration of organic matter, nutrients, and soil biota.
Subsoil	B and C horizons. Soil below topsoil. Lower concentration of organic matter, composed of sand, silt, and clay.
Regolith	Extremely weathered subsoil grading to partially weathered rock, above the groundwater table.
%TS (TS%)	Total sulfur content of a sample generally measured using a ‘Leco’ analyser expressed as %TS.
CRS	Chromium reducible sulfur test measures the sulfide sulfur content of a sample.
Sodic	Sodic soil and rock materials are characterised by a disproportionately high concentration of sodium (Na) in their cation exchange complex and are innately unstable, exhibiting poor physical and chemical properties, which impede water infiltration, water availability, and ultimately plant growth.
Spoil	Side cast overburden and interburden.
Spoil dump	A facility used to store spoil.
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.
SWCC	Soil water characteristic curves
TOC	Total organic carbon
TSS	Total suspended solids is a measurement of the suspended solids concentration in a water sample.

1 Introduction

Nitro Solutions Pty Ltd (Nitro) is contracted by Coking Coal One Pty Ltd (CCO) to assist with the application of an Environmental Authority (EA) amendment and Progressive Rehabilitation and Closure Plan (PRCP) to be assessed by the Queensland Department of Environment and Science (DES) for the development of the Broadmeadow East Project (the Project) subject to Environmental Authority (EA) EA0002465.

RGS Environmental Consultants Pty Ltd (RGS) is contracted to assist Nitro with the interpretation of soil fertility, geochemical and physical information to support a viable mining and PRCP.

This report has been produced based on discussions with Nitro and CCO. CCO require the development of the mine to comply with applicable legislation, regulation, guidelines, standards, and best industry practice.

1.1 Project description

The Project is located on the undeveloped mining lease (ML) ML70257 in the northern Bowen Basin, covering an area of 947 ha in Central Queensland, 25 km northeast of Moranbah and 120 km southwest of Mackay.

The Project is in the planning stage of development with mining intended to be initially open cut with the possibility to transition to underground to be assessed in the future. The planned open pit is located centrally on the mining lease (ML) and runs south south-east to north north-west.

The targeted coal resource within the ML is located within the Leichhardt seam of the Rangal Coal Measures (RCM) formation in the Bowen Basin. Other coal seams exist within the RCM but these are not targeted because they are too thin or discontinuous to recover economically. The RCM are stratigraphically located above the high-ash, non-economic Girrah seam of the Fort Cooper Coal Measures (FCCM). In addition to the open pit, the Project will comprise the following domains: a mining industrial area (MIA), two out of pit spoil dumps (OOPD), diversion channels, clean and dirty water dams, sediment dams, farm dam, roads, and topsoil and subsoil stockpiles to be used for progressive rehabilitation of OOPD.

The raw coal will be transported off-site for processing and to port facilities by exiting rail networks. There is no Coal Handling and Preparation Plan (CHPP) on the site therefore rejects and tailings will be handled offsite at nearby facilities operating under other environmental approvals.

1.1.1 Mining method and dump construction

In pit dumps

When there is a sufficiently large void, waste will be dumped in-pit. Tuff was encountered in several of the boreholes within the Leichhardt seam floor. Hydrothermally altered tuffs can cause issues for low wall dump stability. The dip of the Leichhardt seam floor is in the order of 8-12°, and as such floor treatment in the form of ripping or trenching may be required to prepare the Leichhardt seam floor for dumping of soil in the pit.

OOPD

The OOPD will be built upwards in layers. The rock will roll down the face of the dump at its angle of repose, which is expected to be in the range of 38° to 40°. Intermediate berms will be required should the height of any lift exceed 30 m. No stability problems are anticipated with the ex-pit dump.

The toe of the OOPD should be located a minimum of 20 m back from the crest of the pit, in order to minimise loading on the wall and to facilitate drainage. Site may consider increasing this set back width if access is required. It is assumed that final rehabilitation will require re-shaping to some nominal overall slope angle. It is recommended that the spoil is placed in layers with sufficient setbacks to minimise rehandle.

1.2 Scope

The scope of work undertaken by RGS includes development of this Mine Material Assessment and Land Stability Report. A site visit was not required for this project.

1.3 Purpose

The purpose of this report includes the following:

- Sample and analyse major lithological units from the topsoil to the deepest mined surface to quantify their potential to produce acid, neutral, or alkaline water that may contribute to saline or metalliferous drainage.
- Evaluate the physical properties of the main lithological units and, in combination with the proposed landform design, provide technical advice on the stability of the constructed mine landform.

This mine material assessment and land stability report is to support the EA amendment required prior to major disturbance and transition to the PRCP and Schedule.

- The report will provide information to advise rehabilitation materials storage management, waste material management, and residual void outcomes to support beneficial post-mine land use, inform water and waste management strategies, and comply with the EA conditions in EA0002465.
- For the application of an EA amendment to be approved, the Project must comply with Model Mining Conditions by outlining environmental protection commitments for mine activities on the site.
- This report will contribute to the mine planning stage of the Project by providing recommendations for the management of mine materials to comply with the conditions in EA0002465.
- This report has been built to address the requirements within the PRCP guideline (ESR/2019/4964), relating to 'Waste Characterisation' in section 3.6 of the Guideline.
- Residual risk will be deemed high if the application does not meet all conditions for safe operation and rehabilitation practices (MERFP, 2018).

1.4 Objectives

The objectives of the program of works included the following:

- Develop and supervise (remotely) the sampling program from drill holes and test pits.
- Develop and implement the geochemical and physical sampling and analytical program (GaPSaAP) to enable mine materials to be classified into functional units.
- Quantify the soil fertility, geochemical, and physical properties of the mine materials.
- Evaluate the potential risk of beneficial and deleterious mine materials to produce AMD.
- Assess soil fertility, geochemical, and physical properties of the mine materials to optimise their use for rehabilitation.
- Provide this technical report to outline waste management, landform stability, and rehabilitation objectives to inform the management and mitigation of waste streams encountered during mining.
- Provide supporting documentation for Nitro to assist CCO in the EA amendment and PRCP application.

The work program was completed in accordance with relevant industry guidelines (JORC, 2012; Hazelton and Murphy, 2007 DEHP, 2013; COA, 2016a,b,c; and INAP, 2009).

1.5 Quality, standards, regulation, legislation, and guidelines

Data interpretation and reporting for this report is consistent with the following Australian and international guidelines:

- Progressive Rehabilitation and Closure Plan (PRC plan) progressive rehabilitation and closure plan guideline ESR/2019/4964 • Version 2.00 • Last reviewed: 17 MAR 2021;

- DES (2015) Department of Environment and Science. Application requirements for activities with impacts to land: ESR/2015/1839 • Version 4.03 • Last reviewed: 21 SEP 2021;
- DES (2017) Department of Environment and Science. Model mining conditions: ESR/2016/1936 • Version 6.02 • Effective: 07 MAR 2017;
- DES (2014) Department of Environment and Science. Rehabilitation report: as appropriate for mining resource activities: ESR/2015/1616 • Version 1.04 • Effective 25 JUNE 2014;
- DES (2013) Department of Environment and Science. Application for the certification of progressive rehabilitation: ESR/2015/1563 • Version 2.01 • Effective 23 MAY 2013;
- DES (2020) Department of Environment and Science. Residual Risk Assessment Guideline - Interim ESR/2020/5433 • Version 1.00 • Effective: 2 OCTOBER 2020;
- ACARP (2008). *Development of ARD Assessment for Coal Process Wastes.* ACARP Project C15034. Report prepared by Environmental Geochemistry International and Levay and Co. Environmental Services, ACeSSS University of South Australia, July;
- AMIRA (2002) *ARD Test Handbook - Prediction and Kinetic Control of Acid Mine Drainage; AMIRA International. Project P387A Prediction & Kinetic Control of Acid Mine Drainage.* Ian Wark Research Institute and Environmental Geochemistry International Pty Ltd;
- Commonwealth of Australia (2016). *Leading Practice Sustainable Development Program for the Mining Industry. Preventing Acid and Metalliferous Drainage.* September, Canberra ACT; and
- INAP (2009). *Global Acid Rock Drainage Guide (GARD Guide).* Document prepared by Golder Associates on behalf of the International Network on Acid Prevention (INAP). June 2009 (http://www.inap.com.au/).

1.6 Report structure

A desktop review of the geology and materials at the Project based on supporting geological data, information on sources of potential impacts from coal mines, and supporting background information supplied by Nitro is in **Section 2**.

The sampling program is in **Section 3**.

The soil fertility, geochemical, and physical analytical program is in **Section 4**.

The results of the soil fertility, geochemical, and physical analytical program are in **Section 5**.

The erosion and land stability discussion is in **Section 5.7**.

Conclusions and recommendations are in **Section 7**.

A complete list of references relied upon to complete this report are in **Section 8**.

2 Mine materials

Mine materials within the pit shell at this site include the following:

- **Mine waste** – referred to in this report as 'spoil' including overburden, and exposed coal in the pit walls and exposed coal floor in the base of the pit that requires active management to reduce the potential for adverse environmental effects.
- **Rehabilitation materials** – material to be utilised for cover systems and water management drains that could include oxide (e.g. soil, or fully weathered non-consolidated units such as clay that can be free dug without blasting), transition (include oxide and fresh material), or fresh (competent un-weathered rock) geological units.
- **Cover materials** – material selectively placed within the upper profile of the rehabilitated landform in a cover system. Cover systems are constructed from rehabilitation materials. Cover systems should be designed and constructed to meet specific objectives and design criteria. Chemical and physical characterisation of rehabilitation materials is required to ensure that the cover system will meet the objectives and design criteria.

2.1 Acid and metalliferous drainage (AMD)

The use of consistent terminology is required so the potential for misunderstanding is reduced.

General industry terms that can be used to describe water quality at mines include the following:

- Acid Mine Drainage;
- Acid Rock Drainage;
- Acid and Metalliferous Drainage;
- Neutral Mine Drainage;
- Saline Drainage; and
- Mine Affected Water.

In Australia, AMD is defined as incorporating acidic metalliferous drainage, neutral metalliferous drainage, and saline drainage (COA, 2016). AMD occurs when mined materials are exposed to air and water.

The Project EA defines acid rock drainage as "any contaminated discharge emanating from a mining activity formed through a series of chemical and biological reactions, when geological strata is disturbed and exposed to oxygen and moisture as a result of mining activity". Saline drainage is defined as "the movement of waters, contaminated with salt(s), as a result of the mining activity".

Standard industry terms used to classify the net acid producing potential (NAPP) of mined materials include the following:

- AF (Acid Forming) – is already producing acid;
- PAF (Potentially Acid Forming-High Risk) - will produce acid within days or weeks of exposure;
- PAF (Potentially Acid Forming) - has the potential to produce acid ;
- PAF- LC (Potentially Acid Forming - Low Capacity) - has the potential to produce minor acid ;
- NAF_{BARREN} (Non-Acid Forming-Barren) - will not produce acid or leach salts due to the absence of sulfide minerals (< 0.2% TS);
- NAF (Non-Acid Forming – Low Capacity) - will not produce acid but may leach salts and some metals due to the presence of low sulfide bearing material ;
- NAF (Non-Acid Forming) – may consume some acid and may leach salts and some metals due to the presence of low sulfide bearing material ; and
- AC (Acid Consuming) – has acid neutralising capacity (ANC) that will contribute to ongoing acid neutralisation.

The term 'mine affected water' in this assessment context may include water in:

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

2.1.1 Sources of AMD

Potential sources of acid in mine affected water at mine sites can include:

- oxidation of sulfide minerals such as pyrite (FeS_2) that produce sulfuric acid (H_2SO_4) (INAP, 2009);
- rainfall and leaching of cations such as calcium, magnesium, potassium, and sodium that reduce soil acidification by atmospheric carbonic, nitric, or sulfuric acid; and
- organic matter decay.

Potential sources of salts in mine affected water at mine sites can include:

- oxidation of sulfide minerals, the production of sulfuric acid, and subsequent neutralisation reactions that mobilise major ions such as sulfate (SO_4^{2-}) and calcium;
- chemical weathering of adjacent soil and rock by sulfuric acid that releases major ions such as sodium, potassium, magnesium, and chloride; and
- the mobilisation of sodium chloride (NaCl) or sodium bi-carbonate ($NaHCO_3$) that are present within geological units and groundwater and then released in fluxes as mined materials are extracted (blasted), processed (crushed) and placed into mine landforms.

Potential sources of metals (e.g. Al, Fe, Mn, and Zn) and metalloids (oxyanions such as Mo, Se, and V) in water at mine sites can include elements present:

- as ancillary minerals within primary sulfide minerals like pyrite or marcasite;
- in the solid phase of geological units in a range of minerals; and
- in pore water.

As coal and other geological units are blasted and then extracted from the deposit, the process of chemical weathering increases. If the geological units contain sulfide minerals such as pyrite, the chemical weathering process can increase exponentially due to the oxidation of pyrite and the production of sulfuric acid. The maximum potential acidity (MPA) that the material can produce is calculated by multiplying the total sulfur content in a sample by a stoichiometric factor (30.6), which assumes that all sulfur is present as pyrite and that all pyrite will oxidise to produce acidity. In cases where the materials have some acid neutralising capacity (ANC) the acidity that is produced by the oxidation of pyrite can be neutralised.

If there is more MPA than ANC, the material can potentially produce acidic drainage and the presence of the acidity will increase the concentrations of salts in the form of major ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-} and SO_4^{2-}), metals (e.g., Al, Fe, Mn, and Zn) and metalloids (e.g., Mo and Se). This type of drainage is referred to AMD, although it will also contain elevated concentrations of salts (COA, 2016c).

If there is more ANC than MPA, the material may retain neutral (or alkaline) pH conditions. However, the acid production and neutralisation reactions may still produce elevated concentrations of salts and potentially some metal(loids). This type of drainage is referred to as neutral metalliferous drainage (NMD) or saline drainage (SD).

The potential for a material containing sulfide minerals to produce acidity is also influenced by the way the material is stored or contained. For example, if the material is fine-grained and is contained within a saturated environment the potential for the sulfide minerals to oxidise and produce acidity is lower than if the material is stored in a free draining, oxygenated environment.

The classification of the samples can be derived using the Net Acid Producing Potential (NAPP) or an neutralisation potential ratio (NPR). These calculations are used to classify a material as PAF or NAF. The material classification can be further confirmed by using kinetic geochemical tests on selected mine materials and/or field trials.

When sufficient information is available regarding the geochemical characteristics of the various mining waste materials, a smaller suite of geochemical tests/data may be used to classify a larger number of samples (e.g., total sulfur data) and improve the level of confidence in the overall classification of bulk mine materials (e.g., in coal mines sulfur isopachs and ultimately a sulfur grid layer model can be used to delineate the likely location of any PAF materials) and assist in the refinement of mining material management strategies.

2.1.2 Pathways by which AMD is mobilised

Water on mines includes surface water and groundwater. Groundwater can be considered as water that is present in non-mined ground that has the potential to enter pits (operational pits, backfilled pits, or decommissioned pits). After groundwater enters a pit, it will become mine affected water.

Mine affected water could leave a pit and enter the groundwater system in the receiving environment or become surface water that may then be pumped from the pit. Surface water is present in dams, creeks, and process plants. Seepage from landforms can drain to groundwater or it may appear as resurgent seepage to surface water.

AMD is mobilised by water and is transported from the source materials along aqueous physical pathways into the receiving environment. The salts, metals, and metalloids in aqueous phases can be taken up by aqueous flora and fauna via aqueous biophysical pathways.

Salts, metals, and metalloids present as exchangeable or less soluble fractions (e.g. carbonate or oxide fractions) can also be relocated via physical pathways in the aqueous environment as suspended sediment or bedload sediment.

Salts, metals, and metalloids present in soluble or exchangeable fractions within mined material or process waste can also be taken up by plants via terrestrial biophysical pathways.

Wind borne erosion is another pathway whereby salts, metals, and metalloids can be moved from the source to the receiving environment.

2.2 Existing environment

Natural landforms evolve in the landscape in response to tectonism, geography, and climate and its effect on weathering, topography, the underlying geology, geomorphology, and at a human scale, land use management. The following sections define the baseline conditions of the Project area.

2.2.1 Climate

The Project region experiences warmer summer months and cooler winter months with the majority of rainfall occurring in the warmer months between December and March. This is typical of the tropical Queensland climate.

The average annual rainfall in the area ranges from 122 to 1,295 mm (using most abundant, long term data for the area from Clermont Post Office BoM station 035019, measured from 1870 to 2021).

The highest daily rainfall records in Moranbah range from 94 mm/day (23/08/1988) to 419 mm/day (28-Dec-16). Daily rainfall events such as these can be highly erosive and cause substantial adverse impacts to rehabilitated land. It is these intermittent high energy events that pose a high risk to landform stability.

Intermittent and destructive events such as tropical depression and floods and droughts, heatwaves and bushfires also pose potential risk to landform stability. The Projects constructed mine landforms will need to be designed and managed with this in mind.

2.3 Geology

2.3.1 Regional

The regional surface geology for the Project is comprised of Quaternary, Triassic, and Permian sedimentary sequences (**Figure 2-1**). The significant economic coal seam within the ML is the Leichhardt seam (BL), that sits within the Rangal Coal Measures. Erosion of Triassic sequences due to a reginal scale fault west of the ML has exposed the coal bearing strata (R Johnson, 2007). Based on previous drill hole data, lithologies within the Triassic and Permian strata predominantly include sandstone, mudstone, siltstone, and conglomerate, with minor presence of tuff and ash, and very little carbonaceous material.

The open cut mining process will involve stripping topsoil and subsoil to be stockpiled for rehabilitation. Spoil (overburden, coal roof, reject coal, and coal floor) removed to expose the coal seam will be stockpiled at the spoil dumps. As there is one target coal seam at the Project, no interburden material will be removed from the pit.

The stratigraphic units within ML70257 consist of the following:

Cenozoic sediments

Quaternary soils and alluvium cover the Project area. Soils range from 0.5 m to 1m in thickness and consist of sands, silts, and clays. Thickness of alluvial sediment is on average 2.8 m, and ranges between 0.3 m and 8 m across the Project area. Tertiary sediments were not recorded by drillholes although are known to occur south, west, and north of the Project area.

Triassic Strata

Triassic strata within the Project area consists of the Sagittarius Sandstone sequence within the Rewan Formation. The sequence contains mostly fine grained light greenish-grey lithic sandstone, and conformably overlies the Late Permian Rangal Coal Measures.

Permian Strata

The Rangal Coal Measures comprise interbedded fine to medium grained lithic sandstone, siltstone, mudstone and coal. The coal seams strike north-north-west and include the Burton Rider seam, the Vermont seam, the Upper Vermont seam, the Middle Vermont seam and the Lower Vermont seam, of which only the Leichhardt seam is planned to be mined.

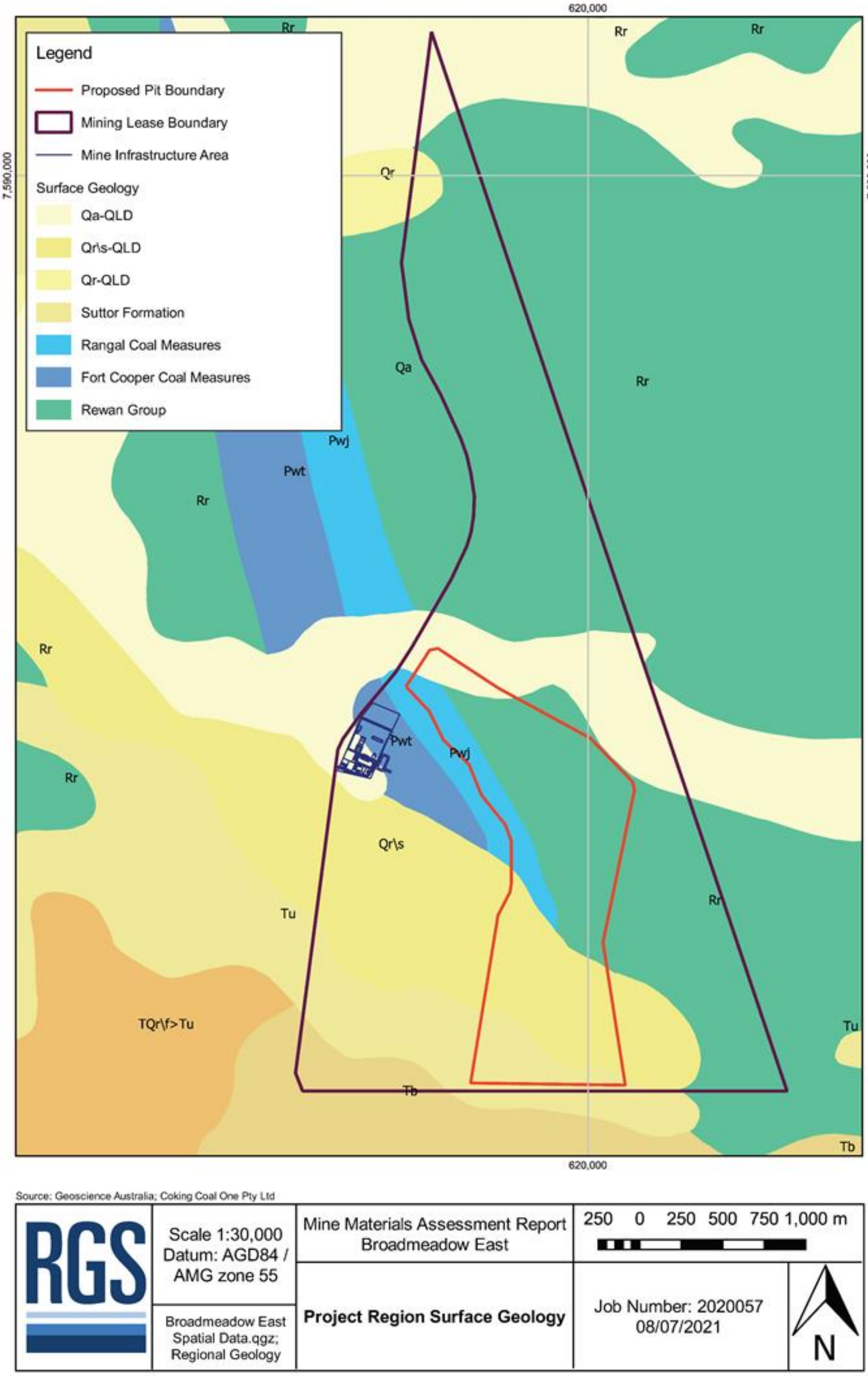

Figure 2-1. Regional geology

2.3.2 Soil

2.3.2.1 Soil forming processes

Soil is formed from additions, losses, transformation, and translocation.

- **Additions**: materials added to the soil, such as decomposing vegetation and organisms (organic matter- OM), or new mineral materials deposited by wind or water.
- **Losses**: Through the movement of wind or water, or uptake by plants, soil particles (sand, silt, clay, and OM) or chemical compounds can be eroded, leached, or harvested from the soil, altering the chemical and physical makeup of the soil.
- **Transformations**: The chemical weathering of sand and formation of clay minerals, transformation of coarse OM into decay resistant organic compounds (humus).
- **Translocations**: Movement of soil constituents (organic or mineral) within the profile and/or between horizons. Over time, this process is one of the more visibly noticeable as alterations in colour, texture, and structure become apparent.

2.3.2.2 Soil classification

Through the interactions of the four soil forming processes, the soil constituents are reorganized into visibly, chemically, and/or physically distinct layers, referred to as horizons. There are typically five soil horizons: O, A, B, and C (R is used to denote bedrock). The soil survey from the SGM Environmental (SGM) (2021) soils report made 240 soil observations from the 330 ha site (**Table 2-1**), 48 with full profile descriptions and laboratory analysis. The Project area contains Chromosol, Dermosol, Kandosol, Kurosol, and Vertosol soil types (SGM, 2021). RGS test pits excavated to 4 m bgl are in mapped soil types that include Chromosol (TP01), Dermosol (TP03), and Kandosol (TP04) (SGM, 2021) (**Figure 2-2**).

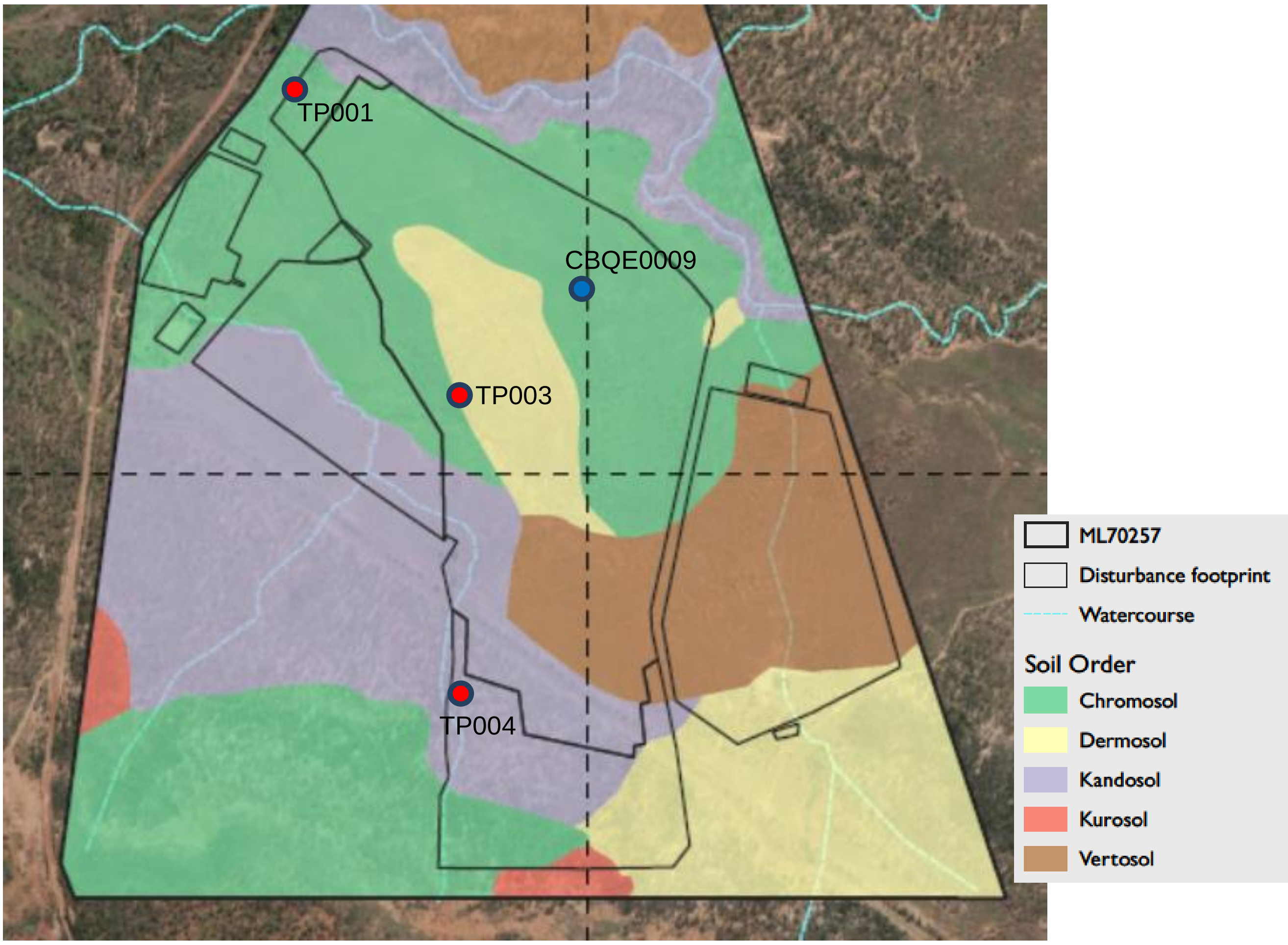

Figure 2-2: Mapped soil types (SGM, 2021)

Table 2-1: Spatial distribution by soil type

Soil	Disturbance footprint (ha)	%
Chromosol	120.5	36.4
Dermosol	45.5	13.8
Kandosol	58.9	17.8
Kurosol	1.0	0.3
Vertosol	104.7	31.7
Total	330.6	100.0

Based RGS test pit work, geotechnical drilling by GTS (2021), and historical geological drill hole logs, topsoil material has been identified at 0.0 m - 0.5 m across the proposed pit area. Subsoil material depth is variable, starting at 0.5 m to depths of 1 m to 6 m below ground level (BGL) with a mean depth value of 3 m across the pit area. Subsoil materials consist of extremely weathered soil, clay, and sand lenses (**Table 2-2**).

Figure 2-3 plots the drill hole locations, materials, and depth of topsoil and subsoil from the historical drill program. As these results are based on data logged in 1978, further testing is required to confirm material depths available.

Table 2-2. Summary of mine material

Material	Description	Depth from	Depth to	Lithology
Topsoil	Top layer of the native soil profile recognised by higher organic carbon content, some development of soil structure, the presence of plant roots, and typically containing the soil seed bank.	0.0	0.5	Soil
Subsoil	Soil layer underlying the native topsoil, typically identified by a decrease in organic carbon content and fewer (and finer) roots. The characteristics of subsoil materials vary markedly depending on the soil type. Subsoils that are not acidic, saline, or sodic are a valuable resource suitable for use during the rehabilitation program.	0.5	1.0	Soil
Subsoil (clay)	Clays with low permeability, high plasticity, and increased soil strength. The characteristics of these materials vary depending on the clay mineralogy and the presence of salts in the landscape. Weathered clay that is not sodic may be suitable for use as a subsoil during the rehabilitation program due to its capacity to retain water. Weathered clay is often used as a sealing layer. Clay-rich topsoil or subsoil may also be substituted.	1.0	6.0	Soil, clay, sand
Extremely weathered regolith	Weathered-rock materials identified by the presence of iron and aluminium oxides. Depending on the chemistry, these materials may be suitable for use as a subsoil or rocky soil mulch layer during the rehabilitation program due to its more favourable physical characteristics when compared to the clay overburden.	1.0	6.0	Soil, clay, silt, sand
Partially weathered regolith	Regolith is weathered rock material that develops into soil through a process called pedogenesis. Over time, extremely weathered soil becomes structured into layers or ‘horizons’ which vary in fertility, due to properties such as nutrients, organic matter, and texture (particle size distribution). By contrast, human-made soils, or anthroposols, have limited or no structure, depending on (1) the complexity of the artificially made cover, and (2) the duration of time since the soil was disturbed.	6.0	25	Clay, silt, sand
Base of weathering (pre mine groundwater level	Depth of weathering is related to the chemical and physical characteristics of materials and their environmental and geomorphic history (EA Bettis, 2007). According to the Hat Creek report (2007), weathering in the Project area was reported 10.0 m – 25.9 m BGL, averaging 16.7 m. Depths of weathering were expected to increase where faults penetrate the profile.	10.0	25.9	Clay, silt, sand

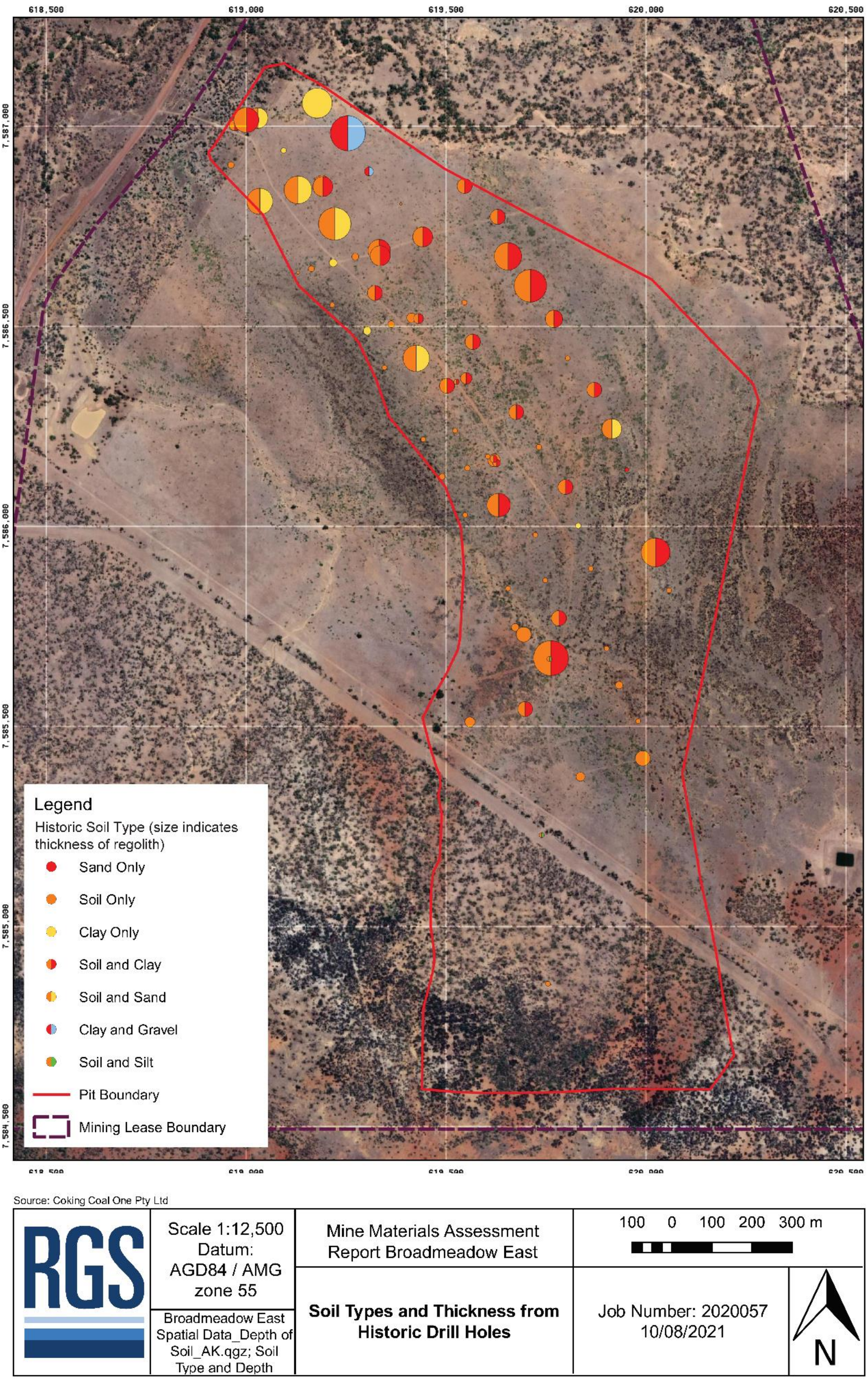

Figure 2-3. Historic soil types and thickness

2.3.3 Overburden

The Project has an extensive geological database including detailed geological logs that verify the proposed open cut pit geology is dominated by siltstone, mudstone, and sandstone (Johnson, 2007).

2.3.4 Coal

The coal resources for the Project are located within the Leichhardt seam of the Rangal Coal Measures (RCM) formation in the Bowen Basin. Other coal seams exist within the RCM but these are not targeted because they are too thin or discontinuous to recover economically. The RCM are stratigraphically located above the high-ash, non-economic Girrah seam of the Fort Cooper Coal Measures (FCCM).

Coal roof, reject coal, and coal floor will be mixed with overburden and emplaced in the OOPD and backfilled into mined void. After excavation of the coal seam, the base of the mined pit will contain exposed coal floor material. The pit walls in the final (residual) void will contain exposed coal roof, coal, and coal floor materials. It is therefore important to assess the characteristics of these materials.

2.3.5 Coal and sulfur

Sulfur in coal is derived from two sources: original plant materials and ambient fluids in the coal forming environment. Abundance of sulfur in coal is controlled by depositional environments and the genesis of the coal seams and overlying strata. Typically, low-sulfur coal seams were deposited in an alluvial environment and the peat was not influenced by seawater. The sulfur in these low-sulfur coals is derived mostly from its parent plant materials.

In contrast, high sulfur coal seams are generally associated with marine strata where sulfate in the seawater diffuses into the peat and is reduced by microorganisms to hydrogen sulfide, elemental sulfur, and polysulfides. During early genesis in such a reducing environment, ferric iron is reduced to ferrous iron, which reacts with hydrogen sulfide to form iron monosulfide. Iron monosulfide is later transformed by reaction with elemental sulfur into sulfide minerals such as pyrite or marcasite.

Organic sulfur is formed by reaction of reduced sulfur species with the humic substances formed by bacterial decomposition of peat. Organic sulfur species in coals are mainly thiols, sulfides, di-sulfides, and thiophene and its derivatives. The thiophenic fraction of organic sulfur increases with the carbon content of coals. Organic sulfur compounds formed in peat are mostly thiols and sulfides, which gradually convert to thiophenes with increasing coal maturation. Thus, the organic sulfur species in coal evolve during the history of coal formation.

At coal mines, PAF materials can be associated with specific coal seams (including coal roof, reject coal, and coal floor materials), as well as some carbonaceous materials (e.g. mudstone) and uneconomic coal seams. For many coal materials the total sulfur concentration is dominated by low-risk organic sulfur rather than sulfur as acid producing minerals such as pyrite or marcasite. The acid producing minerals forms of sulfide can be determined using sulfur speciation analysis or by mineralogy.

Although coal from the Project will be processed off site, it should be noted that coal reject (coarse reject and tailing) materials generated through washing the coal can also have elevated sulfur concentration and depending upon the coal seam or blend of coal seams being washed at the time may be classified as PAF or NAF. In some cases, pyrite/marcasite can preferentially report to either the coarse reject or tailing streams and affect the material classification.

Weathered overburden materials have low sulfide concentrations as any sulfide will have oxidised and been leached from these materials.

The Hat Creek report (Johnson, 2007) includes historical sulfur data for the Leichhardt seam from 1999 to 2006. The total sulfur (TS) was 0.24%TS (19 August 2005) to 1.15 %TS (17 August 2005). Data supplied by M Resources Pty Ltd (M Resources) from the coal quality program 2020 had TS concentrations of 0.05 to 3.14 %TS with a median of 0.41 %TS. TS results from the 2021 GaPSaAP are in **Section 5.1.2**.

2.3.6 Geotechnical assessment and numerical modelling

Previous reporting indicates that Quaternary soils are between 0.5 to 1 m thick, and alluvium (sands, silts, and clays) is between 0.3 to 8 m thick across the Project area (GTS, 2021).

UCS test results indicate that rocks are generally very low to low strength (< 10 MPa) ranging up to 20.5 MPa.

The rock mass can be characterised as comprised of a mostly very low and low strength rock substance that has been extensively deformed resulting in the development of multiple weak defects cutting through the rock mass (GTS 2021).

The very low to low strength fractured rock will not require normal powder factors to achieve adequate fragmentation.

The low rock strength may lead to a high proportion of gravel and fines (relative) to cobble and boulder size fractions that could lead to a higher potential for surface erosion.

3 Sample program

The RGS work program included soil fertility, geochemical, and physical analysis. The sampling program was developed by RGS and undertaken by M Resources under the supervision of RGS. 279 drill hole samples were collected via reverse circulation (RC) drilling from seven drill hole locations along strike of the BL coal seam; 12 soil samples were collected from three test pits adjacent to drill holes, and 33 composite coal, coal roof, and coal floor samples were collected from the coal quality RC drilling program from six drill hole locations (**Figure 3-1**). A summary of samples is in **Table 3-1.** A breakdown of the drill hole samples by lithology is in **Table 3-2**.

Table 3-1. Summary of sample materials

Hole ID	Depth from (m)	Depth to (m)	Number of samples	Soil	Regolith	Coal
Drill holes						
CQBE0001	0	30.5	24	1	23	
CQBE0002	0	45.6	39	2	37	
CQBE0003	0	30.1	29	1	28	
CQBE0004	0	64.8	59	1	58	
RSBE0005	0	66	66	1	60	5
CQBE0006	56.4	61.7	6		5	1
RSBE0007	0	56	56	1	52	3
Test pits						
TP001	0	4	4	4		
TP003	0	4	4	4		
TP004	0	4	4	4		
Coal quality						
CQBE0001	22.6	25.8	5		2	3
CQBE0002	39.7	45.5	7		4	3
CQBE0003	28.2	34.8	10		4	6
CQBE0004	60.4	64.7	3		1	2
CQBE0006	61.8	63.7	2			2
CQBE0008	51.8	56.4	4		2	2
CQBE0006	61.8	63.7	2			2
CQBE0008	51.8	56.4	4		2	2

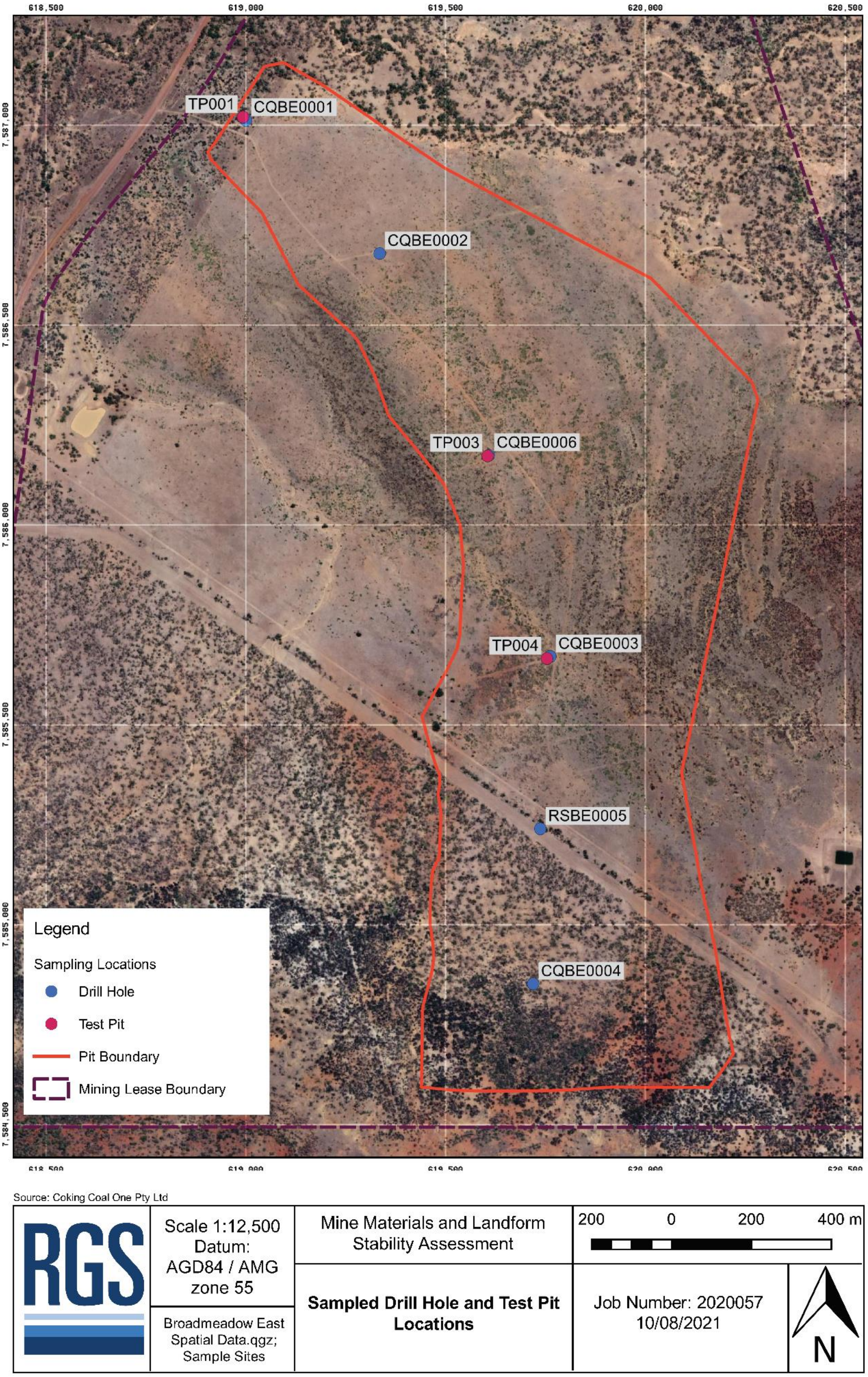

Figure 3-1. Sample sites

Table 3-2. Lithologies of drill hole sample materials

Lithology	Number of samples
Soil	7
Clay	4
Siltstone	198
Sandstone	32
Claystone	1
Carbonaceous sandstone	3
Carbonaceous mudstone	2
Carbonaceous siltstone	20
Coal, carbonaceous mudstone	1
Coal	9
Total	**279**

RGS completed initial $pH_{1:5}$ and $EC_{1:5}$ analysis of 258 chip samples from the seven drill holes before developing the geochemical and physical sampling and analytical program (GaPSaAP) for individual or composited samples. Composite samples were compiled by lithological unit. All compositing of samples by lithology at RGS was based on the geological logs provided by M Resources. The sample program for drill hole samples resulted in four groups of samples (**Table 4-1**).

Table 3-3. Breakdown of samples for each of the four sampling programs (drill hole)

Sample Description	Number of samples
Sample Program 1-1: Composites based on lithology	
Soil	7
Clay	4
Siltstone	38
Sandstone	6
Claystone	1
Siltstone, sandstone	2
Carbonaceous sandstone	1
Carbonaceous siltstone	5
Carbonaceous sandstone, siltstone	1
Carbonaceous siltstone, siltstone	2
Coal	3
Coal, carbonaceous mudstone, carbonaceous siltstone, siltstone	1
Carbonaceous mudstone, siltstone	1
Coal, siltstone	1
Total	**73**
Sample program 1-2: Composites based on sample program 1-1 analysis results	
Soil, clay, siltstone	2
Soil, siltstone	4
Claystone, siltstone	1
Siltstone	7
Sandstone, siltstone	5
Carbonaceous sandstone	1
Carbonaceous sandstone, siltstone	1
Carbonaceous siltstone	3
Carbonaceous siltstone, siltstone	2

Carbonaceous siltstone, siltstone, carbonaceous mudstone, coal	1
Carbonaceous mudstone, siltstone	3
Coal	1
Coal, siltstone	1
Total	**32**
Sample program 1-3: Composites of top 5 m of six drill holes	
Soil, clay, siltstone	2
Soil, siltstone	4
Total	**6**
Sample program 1-4: 1 m samples for top 5 m of six drill holes	
Soil	7
Clay	4
Siltstone	19
Total	**30**

The sample program for test pits has two groups of samples:

- sample program 2-1: Samples per depths received for all three test pits (12)
- sample program 2-2: Samples composited by per depths received across all three pits (4)

The sample program for coal, coal roof, and coal floor has three groups of samples:

- sample program 3-1: Samples as received from site (33)
- sample program 3-2: Samples composited by material (coal, coal roof, coal floor) (3)
- sample program 3-3: Sample program 3-2 split for KLC analysis (6)

The KLC program was split into free draining KLC test work (simulating reactions in the unsaturated zone of a spoil dump), and saturated KLC test work (simulating the reactions occurring when spoil is inundated by rebounding groundwater). The KLC program started in April 2021 and finished in March 2022. The KLC program is explained in **Section 9.3**.

4 Analytical program

Geochemical analysis was completed by ALS Environmental and ALS Minerals, Brisbane, and in RGS in-house laboratory, Brisbane. Physical analyses were completed at Trilab, Brisbane. ALS and Trilab are NATA accredited laboratories. Soil water characteristic curves (SWCC) were produced by Soil Water Group, Perth. soil mineralogy quantitative x-ray diffraction (QXRD) results were produced by Levay & Co. Environmental Services, South Australia.

Static analyses quantify the soil fertility, geochemical, and physical properties of the materials. Kinetic analyses quantify changes over time for soil fertility (e.g. sequential extraction procedures), geochemical (e.g. kinetic leach column analysis) and physical properties (soil water characteristics, permeability, consolidation). Static geochemical analyses included actual acidity ($pH_{1:5}$), salinity ($EC_{1:5}$), total sulfur (TS), acid neutralising capacity (ANC), soil fertility, and whole rock elemental analysis or water-soluble concentrations. This helps to evaluate the potential for AMD to determine the risks and opportunities for their use in rehabilitation. Results from the static geochemical analyses are discussed in **Sections 5.1**, **5.2**, **5.3.3**, and **5.4**. Summary tables are in **Section 9.2**, and raw data is in **Section 9.4**.

Physical analyses determine geotechnical properties and can be used to interpret changes in geochemical behaviour over time, e.g. changes in permeability due to weathering. The susceptibility of rocks to degradation impacts their suitability as rehabilitation materials. This may depend on whether the purpose of the rocks is to: (1) be competent, provide stability, and reduce erosion; or (2) gradually weather from rocky mulch into soil-like material that can be used as a growth medium. Results from the physical analyses are discussed in **Sections 5.3**, **5.4**, and **5.5**, and raw data is in **Sections 9.5**, **9.6**, and **9.7**.

Sections 5.3 and **5.4** interpret both static geochemical and physical analysis to optimise the characterisation of soil properties, salinity, and sodicity for mine material.

Kinetic geochemical analyses are used to determine the long-term characteristics of mine waste material and can be used to further evaluate the potential for AMD. Results from the kinetic analysis are discussed in **Section 5.6**, a summary is in **Section 9.3**, and raw data is in **Section 9.4**.

Explanations of the methodology for sampling and analysing mine waste is in **Section 9.1**. Static geochemical, physical, and kinetic tests performed on drill hole, test pit, and coal quality samples are in **Table 4-1, Table 4-2,** and **Table 4-3**.

Table 4-1. Analysis program for drill hole samples

Geochemical Analyses				
Acid Base Account (ABA)	**ALS Code**	**Method Code**	**Number of analyses**	**Sample program**
$pH_{1:5}$	IN-4S	APHA 4500 H+ - B and APHA 2510 B	73	1-1
NAPP (includes ANC, Total S)	ASS-1	III. Coastech Research (Canada)	73	
Chromium reducible sulfur (S_{cr})	EA026	Ahern et al (2004)	32	1-2
Multi-Element Analyses	**ALS Code**	**Method Code**	**Number of analyses**	**Sample program**
Major, minor, and trace elemental analysis (Total) 49 elements: Ag, Al, As, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn, Zr	ME-MS41 - 2 acid aqua regia digest		32	1-2
Mercury (Total)	EG035T	APHA 3112 Hg-B CV/FIMS	32	
Fluoride (Total)	EK040T	EK040T In-house Fusion	32	
Shake flask extraction leach method (1:3 and 16-hour leach for water soluble elements)	**ALS Code**	**Method Code**	**Number of analyses**	**Sample program**
pH plus EC (1:5)	EA005P and EA010P	APHA 4500 H+ - B and APHA 2510 B	32	1-2
Alkalinity: including Bicarbonate, Carbonate, Hydroxide & Total as CaCO3	ED037	APHA 2320 B	32	
Acidity as CaCO3	ED038	APHA 2310 B	32	
Major cations (Ca, Mg, Na and K) [ICP-AES/MS (1:3 w:v water extracts)] and major anions (Cl, F, and SO4) [ICP-AES/MS and PC Titrator (1:3 w:v water extracts)]	NT-1 & NT-2	APHA 3120B, APHA 3125B	32	
Soluble metal(loids) for 52 elements: (Ag, Al, As, B, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Ge, Hf, Ho, Hg, In, La, Li, Lu, Mn, Mo, Nb, Ni, P, Pr, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn, Zr) [ICP-AES/MS (1:3 w:v water extracts)]	EG020F (ME-02)	USEPA 6020 ICP/MS	32	
Total Nitrogen (including TKN, NOx) Total Phosphorous	NT-11		32	
Reactive Phosphorous as P by discrete analyser	EK071G	APHA 4500 P – F	32	
Dissolved Mercury	EG035F	APHA 3112 Hg-B CV/FIMS	32	
Soil Fertility Analyses	**ALS Code**	**Method Code**	**Number of analyses**	**Sample program**
pH plus EC (1:5)	EA02 and EA010	APHA 4500 H+ - B and APHA 2510 B	30	1-4
Exchangeable Cations (Ca, Mg, Na, K) plus ECEC & ESP on Alkaline Soils (pH > 7.3)	ED006	Soil Survey Test Method C5	30	
Exchangeable Cations (Ca, Mg, Na, K) plus ECEC & ESP with pre-treatment on Soils (pH <7.3 and EC >300µm) NOTE: If pH < 6.0 ECEC includes ED005 - Exchange Acidity (includes Exchangeable	ED008	Rayment & Lyons 2011 15A1 ED005 - Rayment & Lyons 2011 15G1	30	
Total Phosphorus as P by Discrete Analyser	EK067G	APHA 4500-P	30	
Fluoride Extractable Phosphorus (Bray)	EK074	Rayment & Lyons 2011 9E1	30	
Organic Matter Content plus Organic Carbon by Calc' (Walkley Black)	EP004	AS 1289.4.1.1-1997/ NEPM	30	
ED008+EN34+EA02 and EA010 + NT8S Nutrients (TN, TP, TKN, NO_2, NO_3, NH_3 and NO_x)	AG-2	APHA 4500-NH_3 B, APHA 4500 NO_3- B, APHA 4500 NO_3- – I/NO_2- -B, Thermo Scientific Method D08727 and NEMI: 9171, APHA 4500 Norg – D,	30	
Chloride (1:5), pH ($CaCl_2$) Colwell P and K, DTPA extractable Fe, Cu, Zn and Mn, Organic Matter and Organic Carbon by Walkley Black	AG-3	APHA 4500-NH_3 B, APHA 4500 NO_3- B, APHA 4500 NO_3- – I/NO_2- -B, Thermo Scientific Method D08727 and NEMI: 9171, APHA 4500 Norg – D,	30	
Physical Analyses	**Code**	**Method Code**	**Number of analyses**	**Sample program**
Point Load - Either axial, diametral or irregular lump	Based on method	*Samples intact enough to meet minimum requirements for testing*	5	

Table 4-2. Analysis program for test pit samples

Soil Fertility Analyses	ALS Code	Method Code	Number of analyses	Sample program
pH plus EC (1:5)	EA02 and EA010	APHA 4500 H+ - B and APHA 2510 B	12	2-1
Exchangeable Cations (Ca, Mg, Na, K) plus ECEC & ESP on Alkaline Soils (pH > 7.3)	ED006	Soil Survey Test Method C5	12	
Exchangeable Cations (Ca, Mg, Na, K) plus ECEC & ESP with pre-treatment on Soils (pH <7.3 and EC >300µm) NOTE: If pH < 6.0 ECEC includes ED005 - Exchange Acidity (includes Exchangeable	ED008	Rayment & Lyons 2011 15A1 ED005 - Rayment & Lyons 2011 15G1	12	
Total Phosphorus as P by Discrete Analyser	EK067G	APHA 4500-P	12	
Fluoride Extractable Phosphorus (Bray)	EK074	Rayment & Lyons 2011 9E1	12	
Organic Matter Content plus Organic Carbon by Calc' (Walkley Black)	EP004	AS 1289.4.1.1-1997/ NEPM	12	
ED008+EN34+EA02 and EA010 + NT8S Nutrients (TN, TP, TKN, NO_2, NO_3, NH_3 and NO_x)	AG-2	APHA 4500-NH_3 B, APHA 4500 NO_3- B, APHA 4500 NO_3- – I/NO_2- -B, Thermo Scientific Method D08727 and NEMI: 9171, APHA 4500 Norg – D,	12	
Chloride (1:5), pH ($CaCl_2$) Colwell P and K, DTPA extractable Fe, Cu, Zn and Mn, Organic Matter and Organic Carbon by Walkley Black	AG-3	APHA 4500-NH_3 B, APHA 4500 NO_3- B, APHA 4500 NO_3- – I/NO_2- -B, Thermo Scientific Method D08727 and NEMI: 9171, APHA 4500 Norg – D,	12	

Physical Analyses	Code	Method Code	Number of analyses	Sample program
Grading with Hydrometer (includes Particle Density)	Based on method	AS 1289.3.6.1 , AS 1289.3.6.3	12	2-1
Pinhole Dispersion (including STD compaction)	Based on method		4	2-2
Shrink Swell Index	Based on method		4	
Maximum Dry Density - A Mould Standard - 1 litre	Based on method		4	
Permeability (constant or falling head) (90% Proctor)	Based on method		4	
Mineralogical Analysis and Clay Mineralogy	Based on method		4	
Soil Water Characteristic Curve (10 Point)	Based on method		12	2-1
Emerson Class No.	Based on method	AS1289.3.8.1	12	
1 L Column Settlement test 1:3 solid/water ratio	Based on method		12	

Table 4-3. Analysis program for coal quality samples

ABA	ALS Code	Method Code	Number of analyses	Sample program
$pH_{1:5}$	EA02 and EA010	APHA 4500 H+ - B and APHA 2510 B	32	3-1
NAPP (includes ANC, Total S)	ASS-1	III. Coastech Research (Canada)	32	
Chromium reducible sulfur (CRS)	EA026	Ahern et al (2004)	32	
Multi-Element Analyses	**ALS Code**	**Method Code**	**Number of analyses**	**Sample program**
Major, minor and trace elemental analysis (Total) 49 elements: Ag, Al, As, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn, Zr	ME-MS41 - 2 acid aqua regia digest		3	3-2
Mercury (Total)	EG035T	APHA 3112 Hg-B CV/FIMS	3	
Fluoride (Total)	EK040T	EK040T In-house Fusion	3	
Shake flask extraction leach method (1:3 and 16-hour leach for water soluble elements)	**ALS Code**	**Method Code**	**Number of analyses**	**Sample program**
pH plus EC (1:5)	EA005P and EA010P	APHA 4500 H+ - B and APHA 2510 B	3	3-2
Alkalinity: including Bicarbonate, Carbonate, Hydroxide & Total as CaCO3	ED037	APHA 2320 B	3	
Acidity as CaCO3	ED038	APHA 2310 B	3	
Major cations (Ca, Mg, Na and K) [ICP-AES/MS (1:3 w:v water extracts)] and major anions (Cl, F, and SO4) [ICP-AES/MS and PC Titrator (1:3 w:v water extracts)]Cations - Dissolved: Calcium, Magnesium, Sodium, Potassium + Anions: Major (Cl, SO_4, Alkalinity), Fluoride	NT-1 & NT-2	APHA 3120B, APHA 3125B	3	
Soluble metal(loids) for 52 elements: (Ag, Al, As, B, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Ge, Hf, Ho, Hg, In, La, Li, Lu, Mn, Mo, Nb, Ni, P, Pr, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn, Zr) [ICP-AES/MS (1:3 w:v water extracts)]Trace metals by ICP/MS (including digestion)	EG020F (ME-02)	USEPA 6020 ICP/MS	3	
Total Nitrogen (including TKN, NOx) Total Phosphorous	NT-11		3	
Reactive Phosphorous as P by discrete analyser	EK071G	APHA 4500 P – F	3	
Dissolved Mercury	EG035F	APHA 3112 Hg-B CV/FIMS	3	
KLC Analyses	**Code**	**Method Code**	**Number of analyses**	**Sample program**
pH plus EC	EA005P & EA010P		6	3-3
Dissolved Mercury	EG035F	APHA 3112 Hg-B CV/FIMS	6	3-3
Ionic Balance	EN055- PG		6	
ICP/MS Dissolved Metals – Full Scan	ME-02	USEPA 6020 ICP/MS	6	
Major Cations (Ca, Mg, Na, K)	NT-01		6	
Major Anions (Cl, SO4, Fluoride, Alkalinity)	NT-02A		6	
Acidity as CaCO3 only	ED038P CaCO3	APHA 2310 B	6	
Dissolved Major Anions	ED040F		6	
Dissolved Metals by ICPMS – Suite D	EG020D-F		6	
Dissolved Metals by ICP/MS	EG020F	USEPA 6020	6	

5 Results

As samples were taken from undisturbed, natural soils at the Project, the results can be used as baseline values for rehabilitation criteria as the Project progresses through to the end of mine life to ensure sustainable rehabilitation outcomes are maintained.

5.1 Acid base account (ABA)

ABA results are in Sections **9.2.1**, **9.4.2**, **9.4.3**, and **9.4.5**. ABA results are summarised below.

5.1.1 Actual acidity

Actual acidity is quantified with $pH_{1:5}$. Drill hole samples were 5.8 to 9.2 $pH_{1:5}$ with a median of 8.4 $pH_{1:5}$. Coal quality samples were 6.6 to 9.4 $pH_{1:5}$ with a median of 8.9 $pH_{1:5}$. Test pit samples were 8.3 to 9.5 $pH_{1:5}$ with a median of 9.1 $pH_{1:5}$. All samples are circum-neutral to mildly alkaline.

5.1.2 Total sulfur (TS)

The TS of the drill hole samples was below the laboratory limit of reporting (LoR) to 1.75 %TS, with a low median of 0.02 %TS (**Figure 5-1**). All samples $\leq$ 0.2 %S will be NAF_{BARREN}, with low potential for sulfate dominated saline drainage (INAP, 2009). The TS change all coal quality samples was 0.03 to 2.3 %TS with a median of 0.28 %TS (**Figure 5-2**).

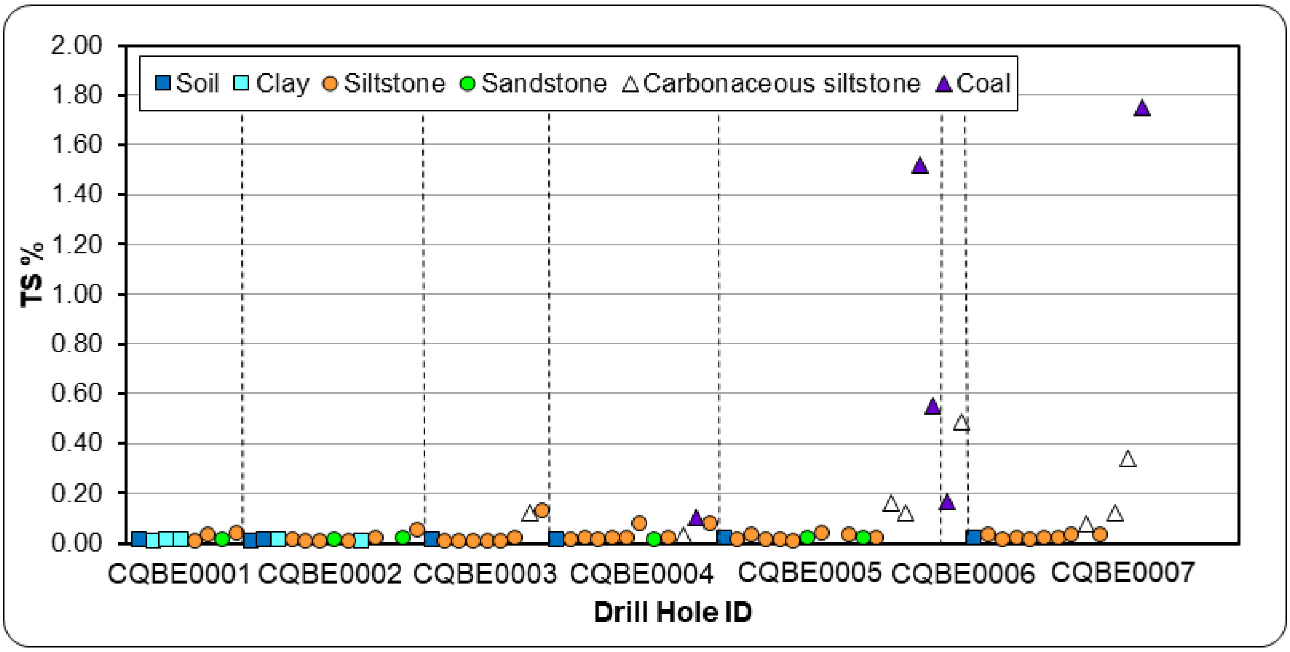

Figure 5-1. TS in drill hole samples

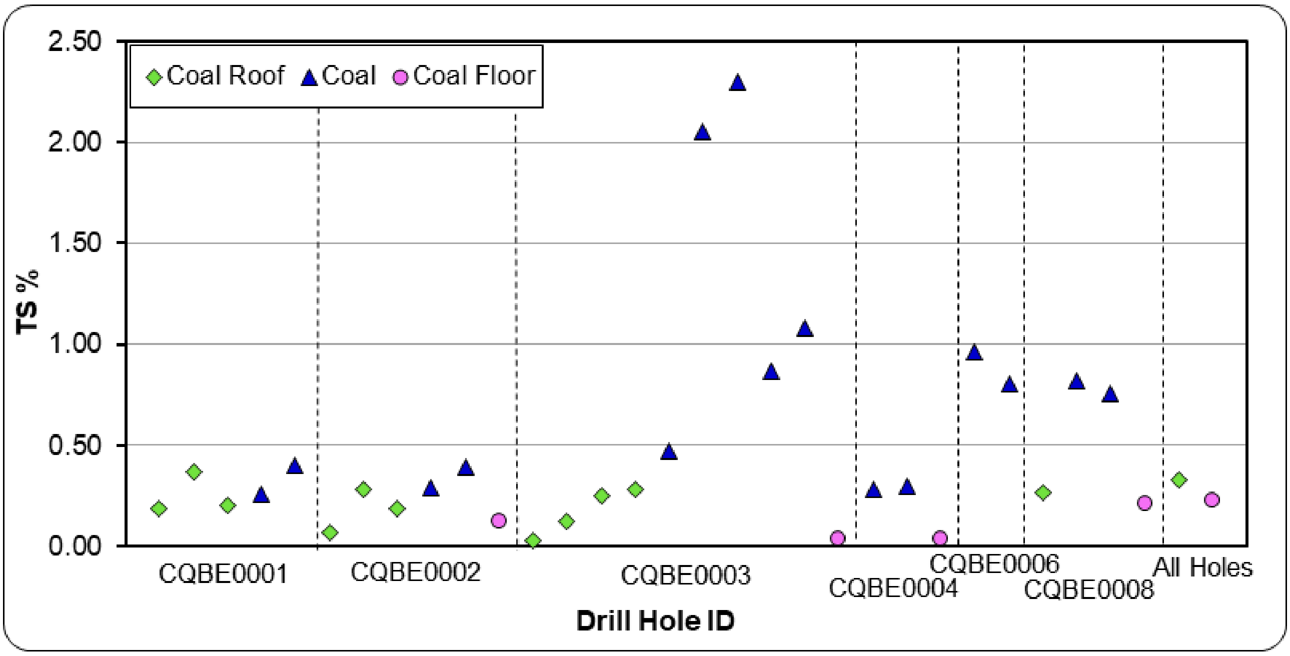

Figure 5-2. TS in coal quality samples

5.1.3 Sulfide sulfur

Sulfide sulfur is measured using the chromium reducible sulfur (CRS) method. The CRS of the drill hole composite samples (n=32) was below the LoR to 1.34 %CRS, with a median of 0.01 %CRS.

The CRS of coal quality samples (n=33) was 0.01 to 1.7 %CRS with a median of 0.28 %CRS. Of the 33 coal quality samples, the percentage of CRS in TS was 4.7 to 85.6 % with a median of 63.9 % (**Figure 5-3**).

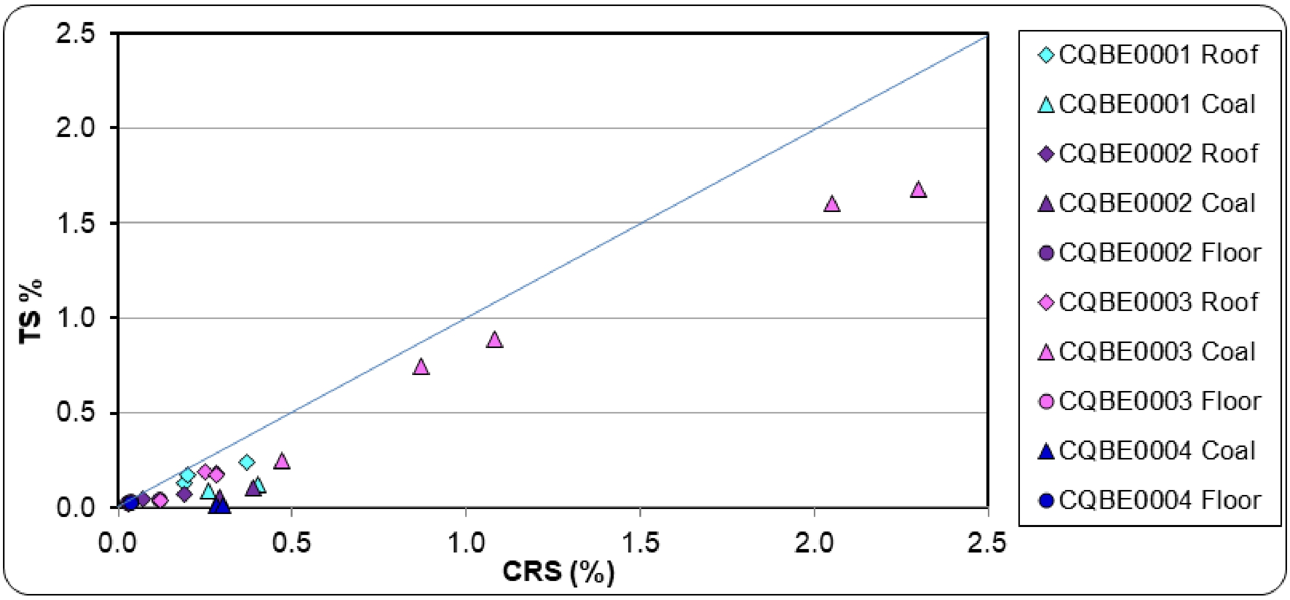

Figure 5-3. TS vs CRS for coal quality samples

5.1.4 Net acid producing potential

The calculated NAPP[2] concentrations (derived using TS) for the spoil samples were - 263.9 to + 39.2 kg H_2SO_4/t with a median of – 20.0 H_2SO_4/t.

The calculated NAPP[2] concentrations (derived using CRS) for the samples were - 264.6 to + 25.4 kg H_2SO_4/t with a median of – 22.5 H_2SO_4/t.

5.1.5 Maximum potential acidity

The maximum potential acidity (MPA²) (derived using TS) for spoil samples was 0.15 to 70.44 kg H_2SO_4/t with a median of 0.92 kg H_2SO_4/t.

The MPA² (derived using CRS) for the samples was 0.08 to 54.45 kg H_2SO_4/t with a median of 0.61 kg H_2SO_4/t.

5.1.6 Total acid neutralising capacity (ANCT)

The total acid neutralising capacity (ANC_T) for the spoil samples was 1.50 to 266.0 kg H_2SO_4/t with a median of 28.40 kg H_2SO_4/t.

5.1.7 Neutralising potential ratio (NPR)

The neutralising potential ratio (NPR) derived using TS for drill hole samples was 0.4 to 1658.8 with a median of 44.6. The NPR derived using CRS was 0.9 to 1528.2 with a median of 56.1.

NPR lines are plotted on NAPP graphs to illustrate the factor of safety associated with the samples. When deriving the MPA² from TS for drill hole samples, one sample plots in the increased risk domain, two samples plot in the possible risk domain, and one sample plots in the low-risk domain. When deriving MPA² from CRS, no samples plot in the increased risk domain, one sample plots in the possible risk domain, and two samples plot in the low-risk domain. Remaining samples plot in the negligible risk domain (**Figure 5-4**).

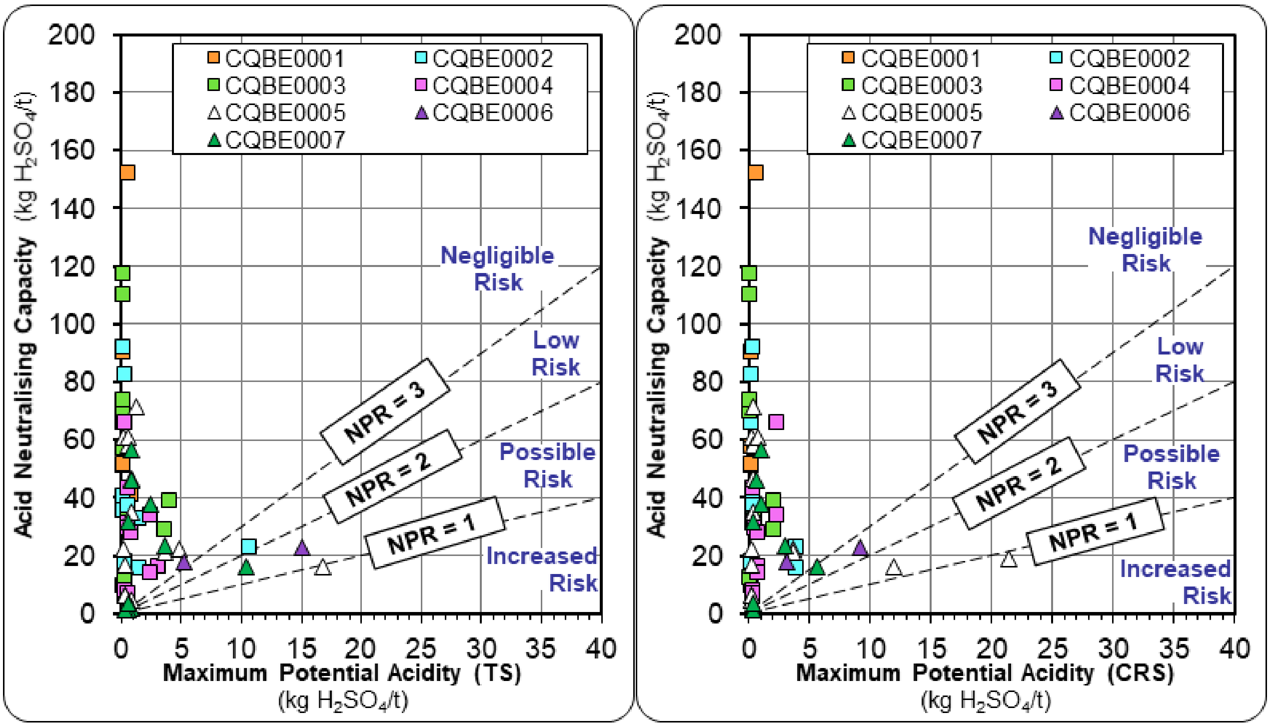

Figure 5-4. NPR (TS and CRS) for drill hole samples

The NPR for coal, coal quality samples was 0.3 to 124.1 with a median of 3.3. The NPR derived using CRS was 0.4 to 184.8 with a median of 5.3.

When deriving the MPA² from TS for coal quality samples, six samples plot in the increased risk domain, two samples plot in the possible risk domain, and five samples plot in the low-risk domain. When deriving MPA² from CRS, three samples plot in the increased risk domain, two samples plot in the possible risk domain, and two samples plot in the low-risk domain. Remaining samples plot in the negligible risk domain (**Figure 5-5**).

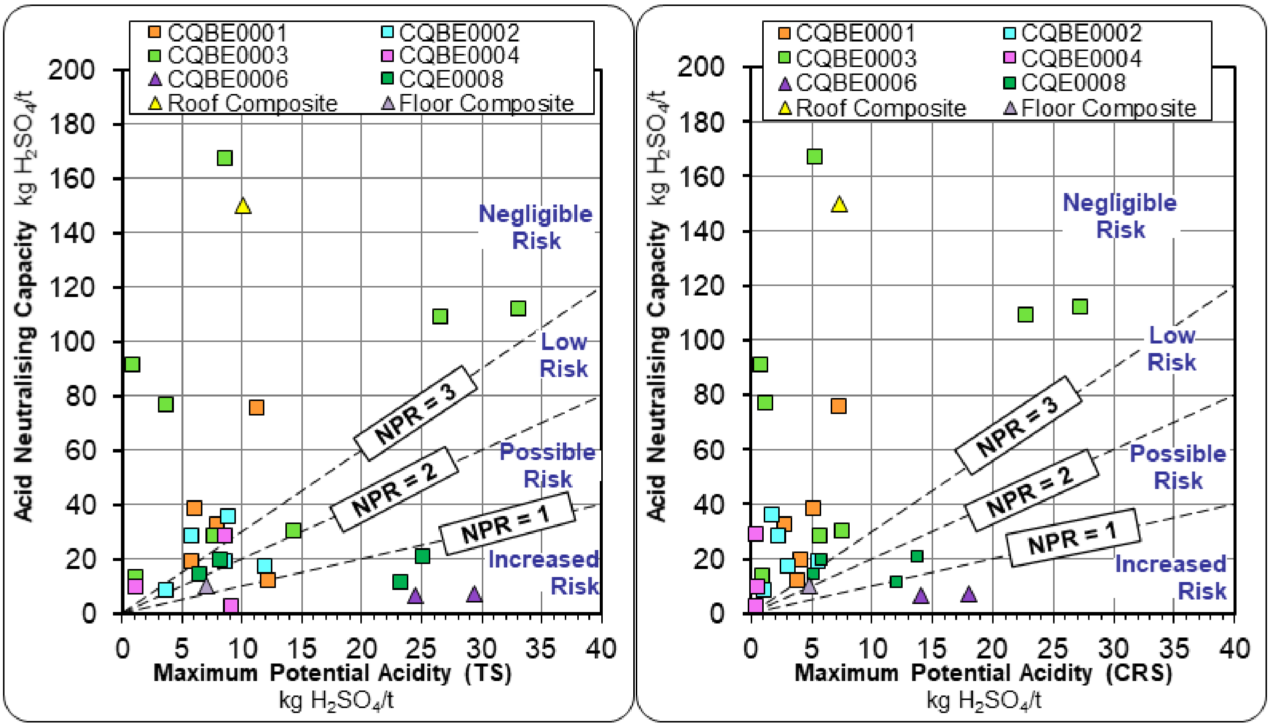

Figure 5-5. (TS and CRS) for coal quality samples

Samples with an NPR ratio of > 3 and/or sulfur content of ≤ 0.2 %TS/CRS have a negligible to low risk of acid generation and a high factor of safety in terms of potential for AMD (COA, 2016; INAP, 2009).

5.1.8 Geochemical classification

The criteria used by RGS to classify AMD potential into seven classes, and the number of spoil samples in each class is in **Table 5-1**. When calculating the geochemical classification from samples using CRS, 91 % (96 samples) are AC to NAF-Low Capacity; with 89 % (93 samples) AC and NAF-Barren. 9 % (9 samples) of spoil samples are PAF-Low Capacity to PAF-High Risk. All samples classified as PAF are coal samples (**Section 9.2.1**).

Table 5-1. Geochemical classification criteria for spoil samples (n = 105)

Geochemical Classification	Total Sulfur[1]/CRS (%)	NAPP (kg H_2SO_4/t)	ANC_T:$MPA_{TS/CRS}$ Ratio	Results using TS	Results using CRS
Acid Consuming (AC)	< 0.2	≤ -100	> 3	7	9
Non-Acid Forming (Barren)	**≤ 0.2**	> -100 ≤ -10	> 2	71	84
Non-Acid Forming (NAF)	> 0.2	> -100 ≤ -10	> 2	9	2
NAF (Low Capacity)	> 0.2	> -10 ≤ 0	< 2	5	1
Potentially Acid Forming (PAF) (Low Capacity)	> 0.2 < 0.5	> 0 ≤ 10	< 2	2	2
PAF	> 0.5 < 1.0	> 10 ≤ 50	< 1	6	4
PAF (High Risk)	> 1.0	> 50	< 1	5	3

Notes:
1. If total sulfur is less than or equal to 0.1 %S, the NAPP and ANC_T:MPA ratio are not required for material classification as the sample is essentially barren of oxidisable sulfur and essentially has negligible capacity to generate acidity through sulfide oxidation.

5.2 Metalliferous drainage

Qua regia 2-acid regia total (referred to as whole rock) multi-element and water soluble results are in **Sections 9.2.2**, **9.2.3**, and **9.4.6**. Results are summarised below.

5.2.1 Whole rock metal(loids)

Whole rock multi-element analyses quantified the concentrations of 54 elements in topsoil, subsoil, and spoil material (**Table 5-2**). Median concentrations of elements in the spoil material have been compared to median concentrations in the topsoil and subsoil using the geochemical abundance index (GAI).

Overburden has a GAI value of < 3 for all elements. Coal has a GAI value of < 3 for all elements except for S. S has a GAI value of 4 in the coal samples; the enriched element may be susceptible to leaching from the material in certain environmental conditions and should be monitored.

5.2.2 Water soluble elements

Water soluble results provide an indication of the environmental mobility and degree of risk associated with major, minor, and trace elements in different samples. Water soluble multi-element concentrations for 52 elements are in **Table 5-3**. Conditional formatting (orange, blue, and green bars) is provided as graphical representation of the distribution of samples within each range of water quality results per material. The mobility of metal(loids) in the solution increases with the range (< 0.0001 ppm immobile to >0.1 ppm maximum mobility). A summary of the results per material is provided below.

Topsoil

- Elements above 1.0 ppm: Na, Ca, K, Mg, Al, Ba, Fe, B
- Elements 0.01 to 1.0 ppm: Al, Ca, K, Mg, Ba, Fe, B, Mn, Sr, Zn, Ti, V, Ce, Li, Pb
- Elements 0.001 to 0.01 ppm: Ag, Ti, V, Ce, Li, Pb As, Be, Bi, Co, Cr, Cs, Cu, Dy, Er, Eu, Ga, Gd, Hf, Ho, In, La, Lu, Mo, Nd, Ni, Pr, Rb, Sb, Se, Sm, Sn, Tb, Te, Th, Tl, Tm, U, Yb, Zr, Cd
- Elements below 0.0001 ppm: Hg, Cd

Overburden

- Elements above 1.0 ppm: K, Na, Ca, Mg, Al, Ba, Sr, B, Fe
- Elements 0.01 to 1.0 ppm: Ca, Mg, Al, Ba, Sr, B, Fe, Zn, Ti, Mo, Se, As, Mn, Li, Sb, Cu, Pb, Ni, V
- Elements 0.001 to 0.01 ppm: Ag, Ti, Mo, Se, As, Mn, Li, Sb, Cu, Pb, Ni, V, Be, Bi, Ce, Co, Cr, Cs, Dy, Er, Eu, Ga, Gd, Hf, Ho, In, La, Lu, Nd, Pr, Rb, Sm, Sn, Tb, Te, Th, Tl, Tm, U, Yb, Zr, Cd
- Elements below 0.0001 ppm: Cd, Hg

Coal

- Elements above 1.0 ppm: K, Na, Ca, Mg, Al, B, Ba, Mn
- Elements 0.01 to 1.0 ppm: Ca, Mg, Sr, Al, B, Ba, Fe, Zn, Ti, Mn, Li, Se, Mo, As, Ni, Co, Sb, Cr, Cu, Pb, Rb
- Elements 0.001 to 0.01 ppm: Ag, Ti, Mn, Li, Se, Mo, As, Ni, Co, Sb, Cr, Cu, Pb, Rb, Be, Bi, Ce, Cs, Dy, Er, Eu, Ga, Gd, Hf, Ho, In, La, Lu, Nd, Pr, Sm, Sn, Tb, Te, Th, Tl, U, V, Yb, Zr, Cd
- Elements below 0.0001 ppm: Cd, Hg

The water soluble results and kinetic leach columns results are being used in a water quality assessment for the Project by Engeny Water Management (Engeny) (2021).

Table 5-2. Summary of whole rock element concentrations

	Topsoil and Subsoil (0.0 - 5.0 m BGL)			Overburden			Coal		
mg/kg	Minimum	Maximum	Median	Minimum	Maximum	Median	Minimum	Maximum	Median
Ag	0.01	0.10	0.06	0.03	0.12	0.08	0.02	0.11	0.05
Al	740.00	1920.00	1340.00	990.00	2250.00	1420.00	430.00	1580.00	800.00
As	3.40	9.20	7.10	2.80	22.90	11.00	1.50	31.70	6.20
Au	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B	5.00	10.00	10.00	5.00	10.00	5.00	5.00	5.00	5.00
Ba	110.00	220.00	165.00	40.00	400.00	115.00	50.00	1160.00	140.00
Be	0.21	0.87	0.85	0.81	1.52	1.16	0.38	1.17	0.69
Bi	0.10	0.19	0.13	0.16	0.47	0.32	0.13	0.40	0.26
Ca	30.00	2310.00	885.00	370.00	3530.00	1425.00	220.00	2600.00	810.00
Cd	0.01	0.07	0.02	0.05	0.15	0.10	0.04	0.13	0.08
Ce	4.17	20.70	15.10	8.20	21.70	15.13	6.45	13.45	8.72
Co	1.80	18.30	12.45	7.60	27.10	15.25	2.50	19.00	8.40
Cr	19.00	90.00	39.50	9.00	27.00	15.00	3.00	11.00	8.00
Cs	0.48	1.65	1.42	1.32	5.58	2.06	0.53	5.00	2.06
Cu	14.90	23.90	19.30	22.40	55.90	43.75	19.40	58.10	36.60
Fe	3150.00	6330.00	4240.00	1200.00	5690.00	4005.00	1160.00	3670.00	2530.00
Ga	3.11	7.09	5.07	2.63	7.84	5.21	0.98	5.13	2.08
Ge	0.05	0.08	0.06	0.03	0.07	0.06	0.03	0.09	0.06
Hf	0.10	0.18	0.13	0.11	0.20	0.14	0.08	0.12	0.10
Hg	0.01	0.01	0.01	0.01	0.12	0.03	0.03	0.31	0.09
In	0.03	0.04	0.03	0.03	0.08	0.05	0.02	0.06	0.05
K	30.00	150.00	115.00	120.00	270.00	165.00	40.00	240.00	130.00
La	1.60	6.80	6.35	3.00	8.70	5.60	2.40	4.90	3.40
Li	2.10	9.50	6.20	7.60	13.90	9.85	3.30	12.40	6.30
Mg	20.00	560.00	265.00	300.00	600.00	515.00	90.00	560.00	220.00
Mn	25.00	881.00	513.50	123.00	1270.00	756.50	102.00	528.00	303.00
Mo	0.13	3.08	0.34	0.10	2.71	0.51	0.74	2.11	1.18
Na	20.00	160.00	100.00	40.00	210.00	85.00	20.00	210.00	60.00
Nb	0.03	0.08	0.06	0.03	0.03	0.03	0.03	0.05	0.03
Ni	3.60	26.20	21.25	17.20	34.40	23.65	4.40	28.50	14.60
P	150.00	320.00	195.00	340.00	1350.00	795.00	270.00	2440.00	1840.00
Pb	4.00	12.70	11.30	10.90	29.60	19.20	4.40	21.90	11.90
Rb	3.50	18.50	12.60	8.00	16.70	11.30	2.30	14.80	7.90
Re	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S	10.00	20.00	15.00	10.00	400.00	30.00	150.00	1900.00	550.00
Sb	0.17	0.46	0.30	0.12	0.95	0.33	0.13	0.82	0.32
Sc	4.80	7.10	5.60	4.60	8.20	7.10	2.50	6.10	3.80
Se	0.20	0.90	0.35	0.20	0.80	0.30	0.50	0.80	0.60
Sn	0.40	0.80	0.65	0.60	1.20	0.75	0.30	0.70	0.50
Sr	6.00	88.60	45.20	30.90	168.50	87.55	71.70	159.50	92.70
Ta	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Te	0.03	0.04	0.03	0.02	0.09	0.05	0.03	0.07	0.06
Th	2.30	3.60	2.90	2.00	4.60	3.55	1.30	5.20	2.10
Ti	2.50	14.00	6.50	2.50	2.50	2.50	2.50	2.50	2.50
Tl	0.02	0.13	0.09	0.01	0.08	0.06	0.01	0.07	0.01
U	0.29	0.59	0.40	0.33	0.66	0.49	0.29	0.94	0.35
V	45.00	205.00	75.00	24.00	54.00	39.50	10.00	31.00	19.00
W	0.15	0.51	0.24	0.03	0.53	0.06	0.03	0.09	0.03
Y	1.15	9.94	8.42	4.94	14.05	10.50	3.47	13.10	6.56
Zn	31.00	54.00	38.00	57.00	99.00	81.50	18.00	113.00	52.00
Zr	3.90	6.90	4.80	3.70	7.00	5.20	3.10	4.50	3.50

Topsoil and subsoil whole rock element results are baseline reference values

Table 5-3. Summary of water-soluble multi-element concentrations (mg/L) by element, concentration, and material type.

	Topsoil					Overburden					Coal			
	≤ 0.0001	> 0.0001 ≤ 0.01	> 0.01 ≤ 1.0	> 1.0		≤ 0.0001	> 0.0001 ≤ 0.01	> 0.0 ≤ 1.0	> 1.0		≤ 0.0001	> 0.0001 ≤ 0.01	> 0.01 ≤ 1.0	> 1.0
Ag	0	6	0	0	Ag	0	22	0	0	Ag	0	7	0	0
Al	0	0	1	5	Al	0	0	8	14	Al	0	0	4	3
As	0	6	0	0	As	0	13	9	0	As	0	4	3	0
B	0	0	3	3	B	0	0	21	1	B	0	0	6	1
Ba	0	0	2	4	Ba	0	0	16	6	Ba	0	0	6	1
Be	0	6	0	0	Be	0	22	0	0	Be	0	7	0	0
Bi	0	6	0	0	Bi	0	22	0	0	Bi	0	7	0	0
Ca	0	0	1	5	Ca	0	0	2	20	Ca	0	0	1	6
Cd	3	3	0	0	Cd	14	8	0	0	Cd	2	5	0	0
Ce	0	5	1	0	Ce	0	22	0	0	Ce	0	7	0	0
Co	0	6	0	0	Co	0	22	0	0	Co	0	5	2	0
Cr	0	6	0	0	Cr	0	22	0	0	Cr	0	6	1	0
Cs	0	6	0	0	Cs	0	22	0	0	Cs	0	7	0	0
Cu	0	6	0	0	Cu	0	20	2	0	Cu	0	6	1	0
Dy	0	6	0	0	Dy	0	22	0	0	Dy	0	7	0	0
Er	0	6	0	0	Er	0	22	0	0	Er	0	7	0	0
Eu	0	6	0	0	Eu	0	22	0	0	Eu	0	7	0	0
Fe	0	0	2	4	Fe	0	0	21	1	Fe	0	0	7	0
Ga	0	6	0	0	Ga	0	22	0	0	Ga	0	7	0	0
Gd	0	6	0	0	Gd	0	22	0	0	Gd	0	7	0	0
Hf	0	6	0	0	Hf	0	22	0	0	Hf	0	7	0	0
Hg	6	0	0	0	Hg	22	0	0	0	Hg	7	0	0	0
Ho	0	6	0	0	Ho	0	22	0	0	Ho	0	7	0	0
In	0	6	0	0	In	0	22	0	0	In	0	7	0	0
K	0	0	1	5	K	0	0	0	22	K	0	0	0	7
La	0	6	0	0	La	0	22	0	0	La	0	7	0	0
Li	0	5	1	0	Li	0	18	3	0	Li	0	2	5	0
Lu	0	6	0	0	Lu	0	22	0	0	Lu	0	7	0	0
Mg	0	0	1	5	Mg	0	0	4	18	Mg	0	0	1	6
Mn	0	0	6	0	Mn	0	14	8	0	Mn	0	2	3	2
Mo	0	6	0	0	Mo	0	7	15	0	Mo	0	3	4	0
Na	0	0	0	6	Na	0	0	0	22	Na	0	0	0	7
Nd	0	6	0	0	Nd	0	22	0	0	Nd	0	7	0	0
Ni	0	6	0	0	Ni	0	21	1	0	Ni	0	4	3	0
Pb	0	5	1	0	Pb	0	20	2	0	Pb	0	6	1	0
Pr	0	6	0	0	Pr	0	22	0	0	Pr	0	7	0	0
Rb	0	6	0	0	Rb	0	22	0	0	Rb	0	6	1	0
Sb	0	6	0	0	Sb	0	19	3	0	Sb	0	5	2	0
Se	0	6	0	0	Se	0	9	10	0	Se	0	2	5	0
Sm	0	6	0	0	Sm	0	22	0	0	Sm	0	7	0	0
Sn	0	6	0	0	Sn	0	22	0	0	Sn	0	7	0	0
Sr	0	0	6	0	Sr	0	0	20	2	Sr	0	0	3	4
Tb	0	6	0	0	Tb	0	22	0	0	Tb	0	7	0	0
Te	0	6	0	0	Te	0	22	0	0	Te	0	7	0	0
Th	0	6	0	0	Th	0	22	0	0	Th	0	7	0	0
Ti	0	1	5	0	Ti	0	3	18	0	Ti	0	1	5	0
Tl	0	6	0	0	Tl	0	22	0	0	Tl	0	7	0	0
Tm	0	6	0	0	Tm	0	22	0	0	Tm	0	7	0	0
U	0	6	0	0	U	0	22	0	0	U	0	7	0	0
V	0	4	2	0	V	0	21	1	0	V	0	7	0	0
Yb	0	6	0	0	Yb	0	22	0	0	Yb	0	7	0	0
Zn	0	0	6	0	Zn	0	0	22	0	Zn	0	0	7	0
Zr	0	6	0	0	Zr	0	22	0	0	Zr	0	7	0	0

5.3 Soil properties

5.3.1 Proposed land use

Rehabilitation works (including temporary rehabilitation) will occur progressively through mining operations as areas become practicably available for rehabilitation activities. Final reshaping, rehabilitation, and mine closure activities are conceptually scheduled to occur from Project Year 7.

CCO intend to manage its operations and conduct decommissioning and rehabilitation activities to ensure that the land disturbed is returned to land suitable for low intensity cattle grazing activities following the completion of mining operations.

CCO has committed to minimal final voids remaining in the landscape at mine closure. If grazing is considered destocking should be considered during the establishment of vegetation to enable rehabilitation to establish to self-sustaining levels.

5.3.2 Soil stripping depth

The maximum recommended stripping depths provided by SGM (2021) are in **Table 5-4**. SGM (2021) recommend stripping topsoil and subsoil to a combined depth of up to 0.5 m bgl.

Table 5-4: Soil stripping depths and material balance recommended by SGM (2021)

Soil type	Depth to strip Topsoil (m)	Depth to strip Subsoil (m)	Topsoil volume (m^3)	Subsoil volume (m^3)
Chromosol	0.30	0.20	361,500	241,000
Dermosol	0.25	0.25	113,750	113,750
Kandosol	0.40	0.10	235,600	58,900
Kurosol	0.40	nil	4,000	-
Vertosol	0.15	nil	157,050	-
Total	-	-	871,900	413,650

SGM (2021) classify topsoil and subsoil using the criteria in **Table 5-4,** whereas (from a mining rehabilitation perspective) RGS classify Topsoil as the 0 to 0.5 m layer, Subsoil#1 as the material from 0.5 to 1m bgl, Subsoil#2 as material 1 m to 2 m bgl and regolith as material 2m to 4 m bgl.

For rehabilitation RGS recommend the following:

- Strip 0 to 0.5 m bgl and stockpile or use as soil to be placed on the upper most surface of rehabilitated land.
- Strip (where practical) 0.5 m bgl up 4.5 m bgl and stockpile or use as subsoil to be placed below the upper most surface of rehabilitated land and over overburden.

5.3.3 Soil fertility

The samples analysed in this assessment all support native vegetation and are suitable for rehabilitation. Comparison of soil results can be done against agricultural guideline values and is appropriate if the end land use will be agricultural. However, in the case of the Projects post mine land use being cattle grazing or rainfed broadacre cropping, the soil fertility results provide reference values for rehabilitation. Soil fertility results are in Section **9.2.4**, **9.4.4**, and **9.4.5**.

5.3.4 Semi-quantitative X-Ray diffraction (mineralogy)

All four samples analysed by semi-quantitative x-ray diffraction (XRD) are dominated (> 70 %) by the quartz and kaolinite (**Table 5-5**). No sulfide minerals were detected.

Kaolinite has low shrink-swell capacity and low cation-exchange capacity, it is durable and has a high degree of plasticity. A dominance of kaolinite clay over smectite clay suggests that these samples are good for rehabilitation, as smectite is a shrink-swell clay, with disruptive properties in environments with changing temperatures and moisture. The XRD report is in **Section 9.6**.

Table 5-5. Semi-Quantitative XRD Mineral percentage in test pit samples

Sample I.D.		2020057_ C2013	2020057_ C2014	2020057_ C2015	2020057_ C2016
Lithology		Soil	Soil	Soil	Soil
Depth (m)		0.0 – 0.5	0.5 – 1.0	1.0 – 2.0	2.0 – 4.0
Mineral Phase	Classification	Mineral Percentage (%)			
Quartz	Silicate	57.9	56.2	56.8	50.8
Kaolinite	Clay (Phyllosilicate)	27.6	25.2	23.5	21.4
Goethite	Clay	6.6	6.9	6.4	5.9
Albite	Plagioclase (Tectosilicate)	2.6	3	4.8	8.4
Calcite	Calcium Carbonate	0.6	3.1	2.4	5.2
Microcline	Silicate	2.7	2.7	2.7	2.6
Smectite	Clay (Phyllosilicate)	1.4	1.6	1.5	1.4
Chlorite	Silicate	0.1	0.9	1.3	3.5
Illite	Clay (Phyllosilicate)	0.5	0.4	0.6	0.8

5.3.5 PSD and hydrometer

The particle size distribution (PSD) and hydrometer results of the 12 test pit samples are in **Figure 5-6** and were done on < 5 mm PSD fractions. The PSD results verify the high proportion of fine sand, silt and clay that is present in the soil profile, and support the low permeability findings in **Section 5.3.7** and high capacity to hold water found from the SWCC (**Section 5.3.8**). PSD and hydrometer reports are in **Section 9.5.1**.

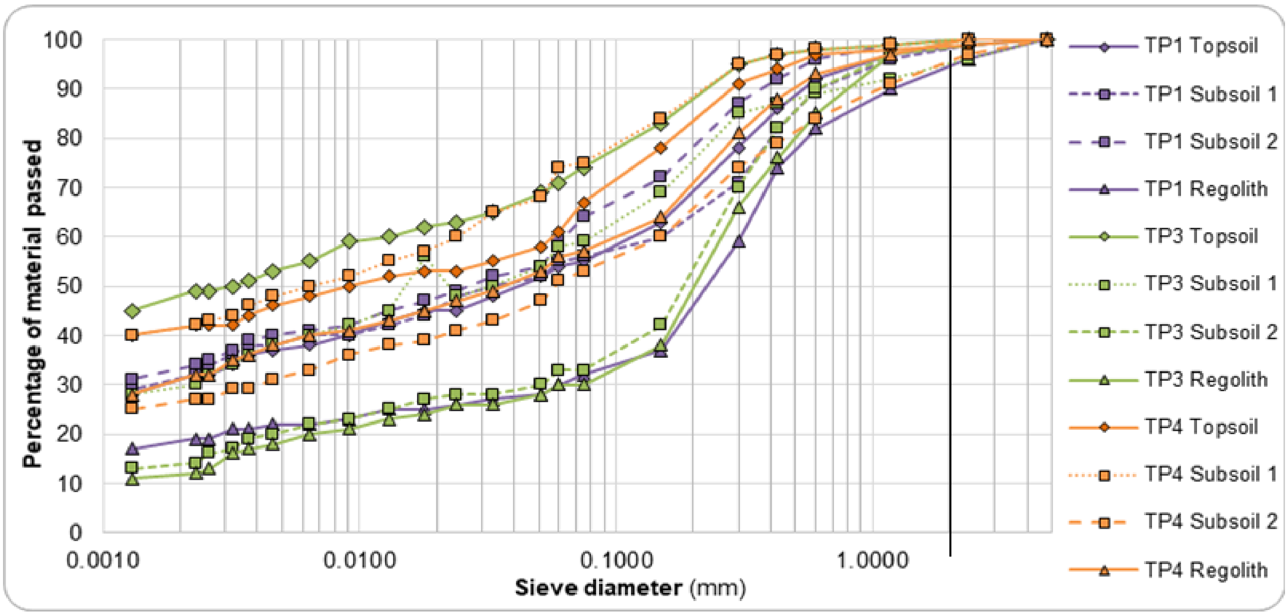

Figure 5-6. PSD and hydrometer for test pit samples

5.3.6 Shrink-swell

Shrink-swell results show that all samples have no cracking, crumbling, or shrink-swell potential. This supports the mineralogy results and properties of the kaolinite clay found as the dominant mineral in test pit samples (**Section 5.3.4**). Full shrink-swell reports are in **Section 9.5.2**.

Table 5-6. Shrink-swell for test pit samples

Test pit depth	Swell (%)	Shrinkage (%)	Shrink swell index (ISS) (%)
0.0 – 0.5	0.3	2.0	1.2
0.5 – 1.0	0.3	1.7	1.0
1.0 – 2.0	0.1	0.4	0.2
2.0 – 4.0	0.1	0.1	0.1

5.3.7 Permeability

Permeability for the four samples was 2.2 x 10^{-9} to 1.7 x 10^{-8}: k_{sat} concentrations increased with depth. Material in this range is dominated by fissures, desiccated weathered clay, and has poor drainage (Look, 2017). Permeability (k) reports for the test pit samples are in **Section 9.5.3**.

5.3.8 Soil-water characteristic curves

Soil water characteristic curves (SWCC) measure the limits of water storage capacity of materials. There is an upper limit (field capacity) and lower limit (permanent wilting point). The point between the limits is the plant available water.

After rainfall events, infiltration occurs due to gravity, which is referred to as drainage. Soil moisture decreases through this process; the rate that the moisture of the materials decreases is dependent on soil texture class. Typically, soils with a higher clay content retain water for longer. **Figure 5-7** plots the water retention properties for the test pit samples. The SWCC report is in **Section 9.7**.

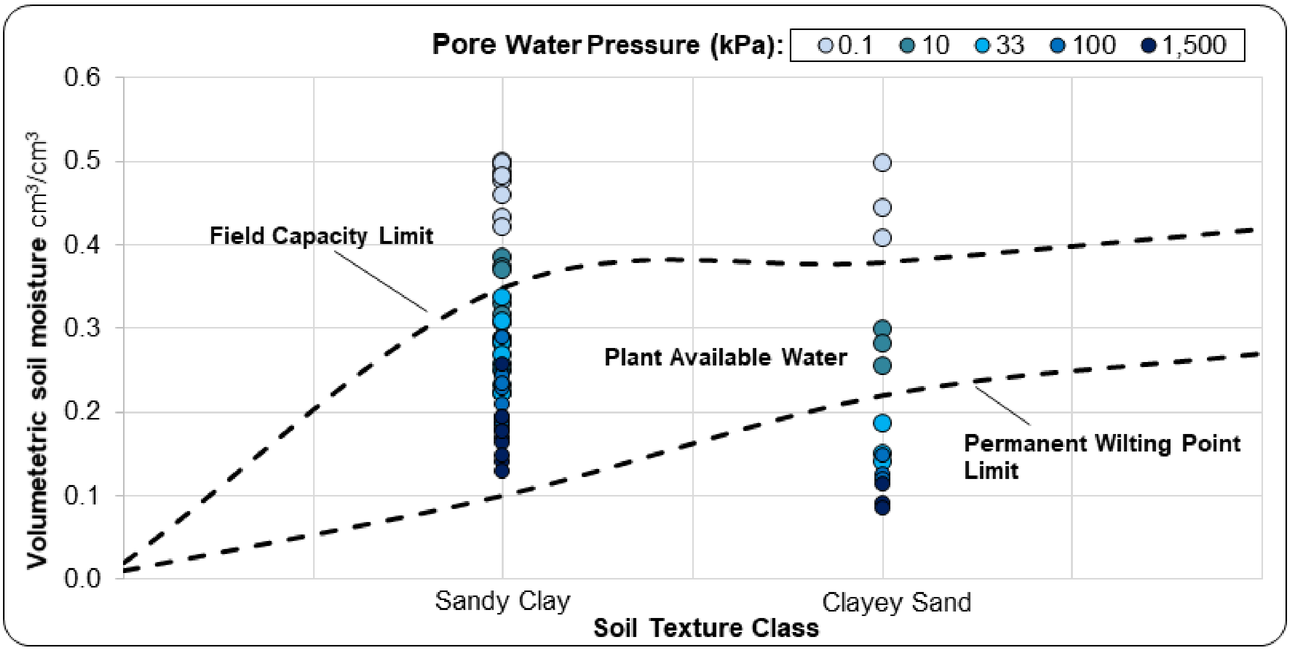

Figure 5-7. Graph of plant available water and soil texture class

5.3.9 Pin-hole dispersion

Composite topsoil, subsoils, and regolith from the test pit samples are completely erosion resistant. These findings support the results of the Emerson Aggregate test (EAT) (**Section 5.4.3**), Rengasamy soil classifications (**Section 5.4.3.1**), and settling columns (**Section 5.4.4**). Pin-hole dispersion reports are in **Section 9.5.4**.

5.4 Soil salinity, sodicity, and aggregate stability

5.4.1 Electrical conductivity

The $EC_{1:5}$ for the drill hole samples was 72 to 1,210 µS/cm with a median of 408 µS/cm. $EC_{1:5}$ for coal quality samples was 78 to 1,210 µS/cm with a median of 395 µS/cm. $EC_{1:5}$ for test pit samples was 82 to 781 µS/cm with a median of 188 µS/cm.

5.4.2 Cation exchange capacity and exchangeable sodium percentage

ESP was below LoR to 33.6 % with a median of 7.3 % in test pit samples. ESP was below LoR to 49.8 % with a median of 31.3 % in drill hole samples. A summary for CEC and exchangeable cation concentrations are in **Table 5-7** and **Table 5-8**. Exchangeable sodium percent (ESP) and cation exchange capacity (CEC) results are in Sections **9.2.4**, **9.4.4**, and **9.4.5**.

Table 5-7. CEC and exchangeable cation concentrations for drill hole samples

Parameter	Topsoil (0.0 – 0.5 m)			Subsoil (0.5 – 4.0 m)		
(meq/100 g)	Minimum	Median	Maximum	Minimum	Median	Maximum
CEC	ND	3.0	8.5	0.1	6.8	11.1
Exchangeable Na	ND	0.1	2.8	0.1	2.3	4.2
Exchangeable K	ND	0.1	0.1	0.1	0.1	0.3
Exchangeable Ca	ND	0.3	2.0	ND	1.1	4.7
Exchangeable Mg	ND	0.4	3.5	0.1	3.4	5.4

Table 5-8. CEC and exchangeable cation concentrations for test pit samples

Parameter	Topsoil (0.0 – 1.0 m)			Subsoil (1.0 – 5.0 m)		
(meq/100 g)	Minimum	Median	Maximum	Minimum	Median	Maximum
CEC	8.1	10.9	15.3	0.1	10.2	12.1
Exchangeable Na	0.1	0.3	0.1	0.1	0.8	3.4
Exchangeable K	0.2	0.4	0.6	0.1	0.1	0.3
Exchangeable Ca	5.5	5.5	12.1	.01	3.4	8.8
Exchangeable Mg	2.0	2.8	3.8	0.1	3.6	5.4

5.4.3 Emerson class

Test pit samples analysed for the Emerson Aggregate test (EAT) were consistently described as sandy clay, with some clayey sand in deeper layers within Test Pits 1 and 4 (**Table 5-9**). Test Pit 3 had an Emerson Class Number (ECN) of 4, this class is described to have no dispersion characteristics and carbonate or gypsum presence (**Table 5-10**). Test Pits 1 and 4 had ECN of 2 – 3, this class is described to have slaking with some dispersion characteristics. The EAT reports are in **Section 9.5.5**.

Table 5-9. Emerson class test results for test pit samples

Test Pit	TP001	TP001	TP001	TP001
Material	Topsoil	Subsoil	Subsoil	Subsoil
Depth (m)	0 - 0.5	0.5 – 1.0	1.0 – 2.0	2.0 – 4.0
Description	Sandy CLAY – brown	Sandy CLAY – brown	Sandy CLAY – brown	Clayey SAND - brown
Emerson Class Number	**2**	**2**	**2**	**2**

Test Pit	TP003	TP003	TP003	TP003
Material	Topsoil	Subsoil	Subsoil	Subsoil
Depth (m)	0 - 0.5	0.5 – 1.0	1.0 – 2.0	2.0 – 4.0
Description	Sandy CLAY – brown	Sandy CLAY – brown	Clayey SAND - brown	Clayey SAND - brown
Emerson Class Number	**4**	**4**	**4**	**4**

Test Pit	TP004	TP004	TP004	TP004
Material	Topsoil	Subsoil	Subsoil	Subsoil
Depth (m)	0 - 0.5	0.5 – 1.0	1.0 – 2.0	2.0 – 4.0
Description	Sandy CLAY – brown	Sandy CLAY – brown	Sandy CLAY – brown	Sandy CLAY – brown
Emerson Class Number	**3**	**3**	**2**	**2**

Table 5-10. Emerson aggregate stability description

Class	Emerson aggregate class description
1	Slaking, complete dispersion
2	Slaking, some dispersion
3	Dispersion after remould at water content equivalent to Field Capacity
4	Carbonate or gypsum present
5	Dispersion (DP >= 6) after 1:5 soil-to-water suspension
6	Complete flocculation (DP< 6) after 1:5 soil-to-water suspension
7	No dispersion (slaking or swelling)
8	No dispersion (no slaking or swelling)

5.4.3.1 Rengasamy classification

EC and ESP results are plotted using the Rengasamy *et al* (1984) soil classification (**Table 5-11**) to quantify the potential for dispersion or flocculation and salinity of topsoil and subsoil samples from drill holes and test pits (**Figure 5-8**).

75 % of test pit samples are Class 2 (n=9) and classified as potentially dispersive, ranging from Class 2A (n=6) and Class 2B (n=3). All test pit topsoil samples are Class 2. The remaining samples are Class 1 (n=2); dispersive and potentially sodic, and Class 3C (n=1); non-sodic and flocculated.

Over half (n = 16) drill hole samples are Class 1. The remaining samples are Class 2, ranging from Class 2A (n = 11) and class 2B (n = 3). Five of the six drill hole topsoil samples are Class 2A with ESP concentrations below LoR. The remaining drill hole topsoil sample is Class 1.

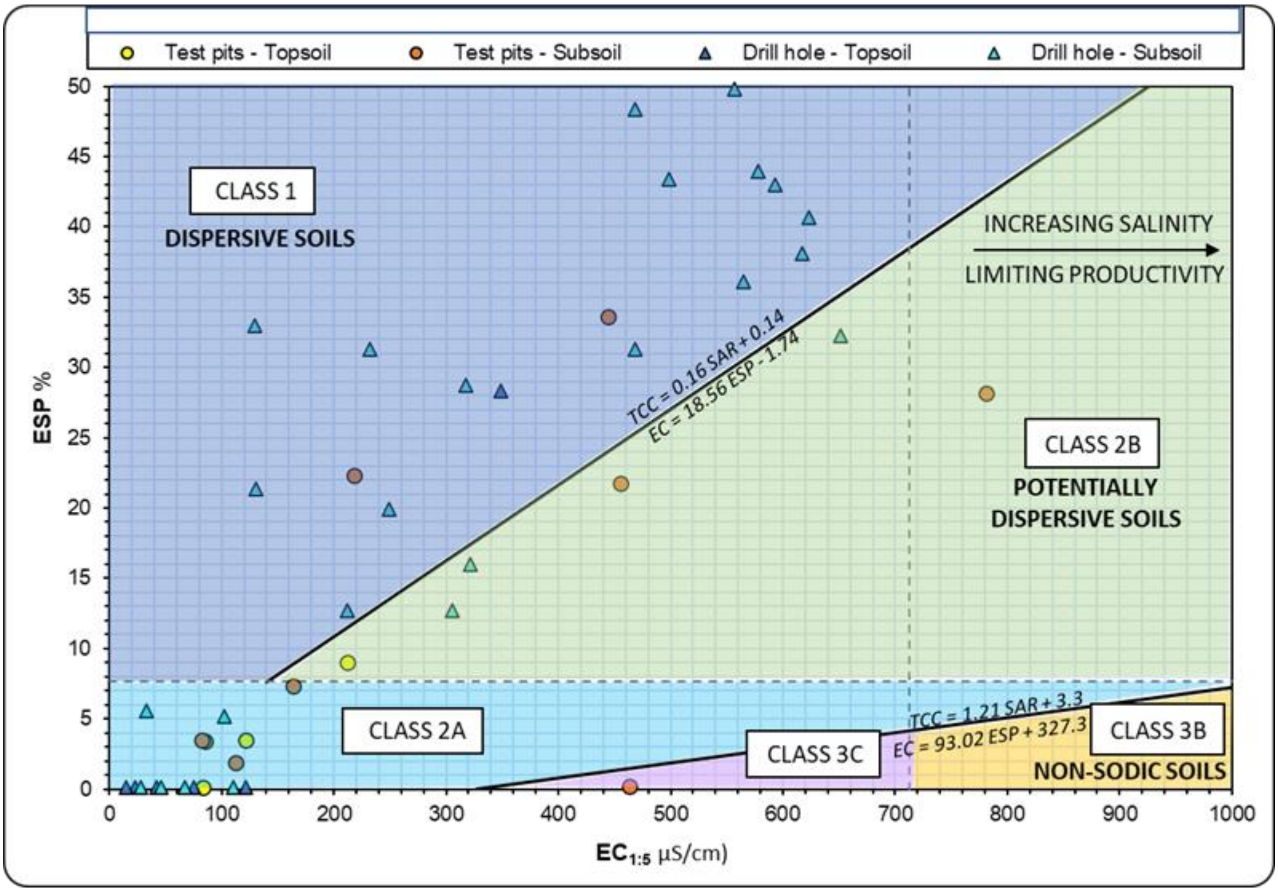

Figure 5-8: Rengasamy soil classification

Table 5-11: Rengasamy aggregate stability description

Class	Rengasamy aggregate class description
1	Soils which disperse spontaneously
2	Soils which disperse after mechanical shaking are potentially dispersive
2A	Soils from the A-horizon of red-brown earths with a SAR of less than 3 and which mechanically disperse, require an electrolyte concentration of (1.21SAR + 3.3) m.e. 1- for structural stability. Class 2a soils will have few structural problems if managed using minimum tillage techniques or if maintained under continuous pasture growth.
2B	Surface (A-horizon) soils with a SAR above 3 require an electrolyte level similar to class 2a soils in order to maintain flocculation. Unlike class 2a soils, these soils become spontaneously dispersive (class 1) when leached without the addition of calcium compounds, and if there is no generation of electrolytes in the soils due to mineral weathering (Shainberg et al. 1981).

3	When soils have more than the minimum required electrolyte levels (as defined by equations 3 to 6), they remain flocculated when subjected to rainfall, irrigation or mechanical stress.
3A	If the SAR of a soil is above 3 and its TCC exceeds the flocculation value, then it is saline and sodic. Leaching with good quality water may change a saline-sodic soil to class 2b (e.g. Quirk 1971), or on extreme leaching to class 1. The soil may consequently disperse and cause severe crusting
3B	These soils have no physical problems, and their leaching requirements depend on the salt tolerance of the crops to be grown.
3C	When the SAR is less than 3 and the TCC is ideally similar to the flocculation level, there are no dispersion or salinity problems.

5.4.4 Settling columns

Settling column tests were performed at the RGS laboratory to understand how particles in the material settle out of suspension from water. Large and heavy sand particles will settle quicker than small and light clay particles. **Figure 5-9** shows column settlement tests for topsoil (0 to 50 cm bgl), subsoil unit 1 (0.5 to 1m bgl), subsoil unit 2 (1 to 2 m bgl) and regolith (2 to 4 m bgl) at TP01, TP02 and TP03 at time zero and 114 hours. These analyses show increasing rates of dispersion in TP01 with depth (classified as **Chromosol** by SGM, 2021), low and consistent rates of dispersion in TP02 (classified as **Dermosol** by SGM, 2021), and increasing rates of dispersion in TP03 (classified as **Kandosol** by SGM, 2021),'

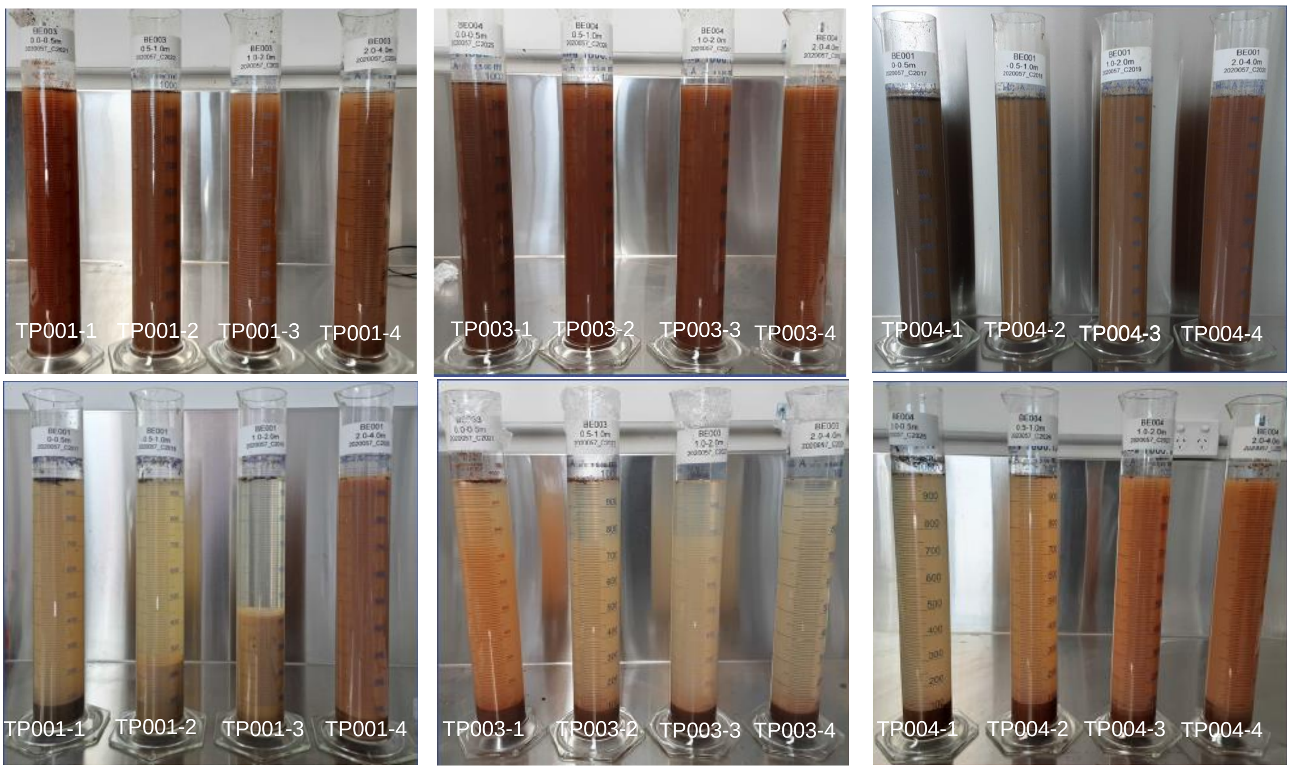

Figure 5-9: **Suspended sediment settlement at 0 hours (top) and 114 hours (bottom) for Topsoil, Subsoil#1, Subsoil#2 and regolith in TP001, TP003 and TP004 (left to right)**

The findings of the soil column settlement analysis are consistent with some of the SGM (2021) findings, for example:

- RGS TP001 is in an area logged and classified by SGM (2021) as Brown Chromosol. SGM (2021) determined that this unit has non-sodic subsoil (assumed to include the B21 and B22 horizon from 0.35 to 1 m bgl) and is unlikely to be dispersive. The SGM (2021) subsoil horizon align with the RGS subsoil sample (TP001-2). These findings are not however applicable to the subsoil and upper regolith from 1 m bgl to 4 m bgl.

- RGS TP003 is in an area logged and classified by SGM (2021) as Dermosol. SGM (2021) determined that this unit has non-sodic subsoil (assumed to include the B21 and B22 horizon from 0.41 to 1 m bgl) and is unlikely to be dispersive. These findings are consistent with the RGS settlement analysis in all units including the subsoil and upper regolith from 1 m bgl to 4 m bgl.
- RGS TP004 is in an area logged and classified by SGM (2021) as Kandosol. SGM (2021) determined that this unit has non-sodic subsoil (assumed to include the B21 and B22 horizon from 0.33 to 1 m bgl) and is unlikely to be dispersive. The SGM (2021) subsoil horizon align with the RGS subsoil sample (TP004-2). These findings are not however applicable to the subsoil and upper regolith from 1 m bgl to 4 m bgl, that retain high dispersion.

5.4.5 Erosion

Soil loss estimates were computed by SGM (2021) to enable effective erosion and sediment control measures to be put in place during project development and to aid mitigation measures designed to reduce the erosion potential in post-mining landforms.

Final constructed landforms are proposed to be low relief with flat crests, and gently to moderately inclined slope lengths at a maximum of 7 degrees.

The SGM erosion rates on bare soil were an average 35 to 61 t/ha/yr up to maximum values of 84 to 106 t/ha/yr. Rehabilitated erosion rates were calculated to be 0.45 to 1.22 t/ha/yr with > 80 % cover.

Reported erosion rates at Curragh, Goonyella Riverside and Oaky Creek were 86 to 238 t/ha/yr from bare soil and 78 to 280 t/ha/yr from bare spoil (Carroll, Pink, and Burger, 2004).

5.5 Rock properties

5.5.1 Point load strength

RGS sent five samples for point load strength tests from drill holes CQBE0001, CQBE0002, and CQBE0006. Axial load direction tests were performed on all five samples, an additional diametral test and irregular lump test was performed on the two samples from drill hole CQBE001. RGS was provided with data for 13 samples from drill hole CGBE0009 from the GeoTek Geotechnical Report (2021). All 13 samples were tested under the uniaxial load direction test. Results are plotted by strength and depth in **Figure 5-10**; the figure shows all samples are within medium to extra high point load strength ($Is_{(50)}$). This is consistent to the sandstone lithologies at the Project. Point load strength reports are in **Section 9.5.6**.

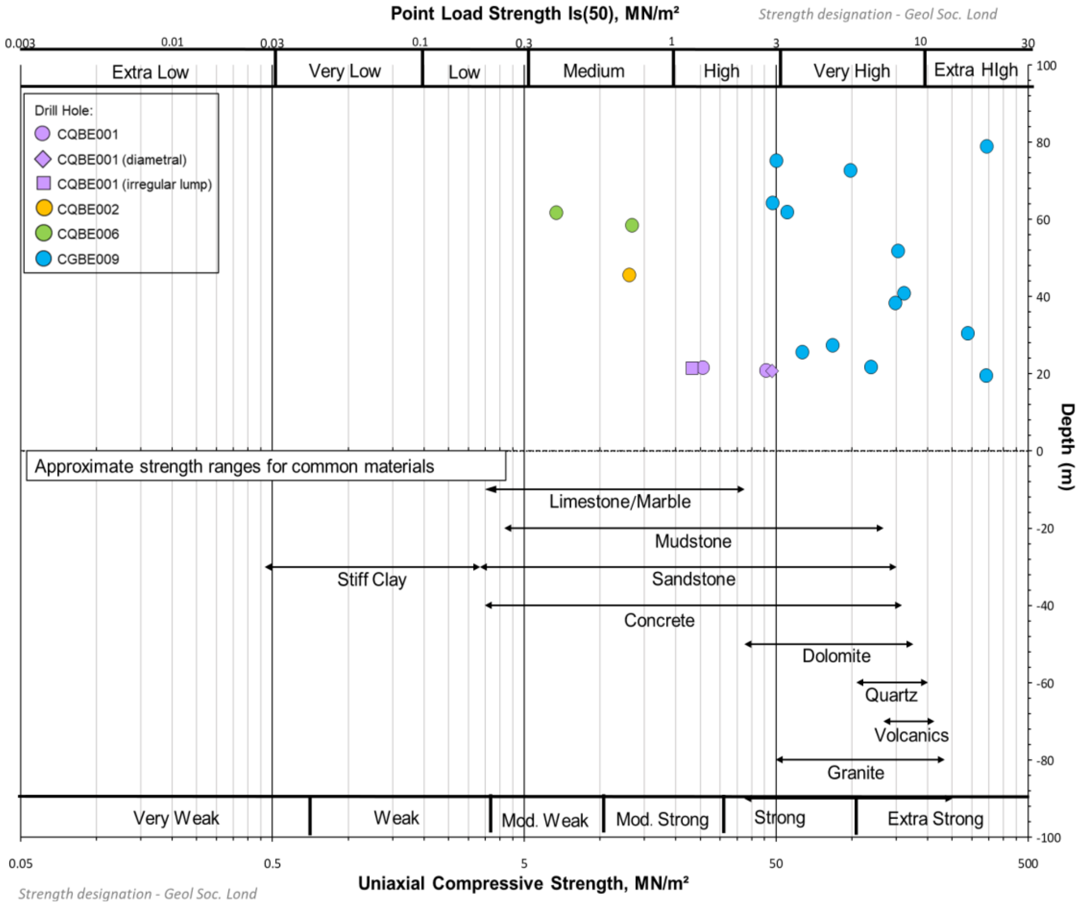

Figure 5-10. Point load strength of overburden materials compared to standard materials

5.6 Kinetic test results

Kinetic Leach Column (KLC) tests run over time; KLC leach events for the Project commenced 30/04/2021. Saturated columns ran weekly for four weeks and ended 20/05/2021. Free-leach columns ran monthly for 12 months and ended 03/03/2022. pH stayed stable over the leach events and EC has decreased over time in all columns (**Table 5-12**). There has been no enriched metal(loids) reported in the KLC program for coal roof, coal, or coal floor samples. KLC results are in **Section 9.3** and **9.4.1**.

Table 5-12. Summary of KLC leach results

KLC column and material	Parameter	Leach #1	Leach #2	Leach #3	Leach #4	Leach #5	Leach #6	Leach #7	Leach #8	Leach #9	Leach #10	Leach #11	Leach #12
KLC 1 roof (saturated)	pH	8.08	8.15	8.20	8.31								
	EC	1850	1360	918	664								
KLC 2 roof (free-leach)	pH	8.17	8.21	8.18	8.27	8.40	8.50	8.25	8.40	8.37	8.15	8.25	8.09
	EC	1880	1640	1260	817	709	602	612	586	510	502	508	419
KLC 3 coal (saturated)	pH	7.84	7.88	7.95	7.97								
	EC	1350	1910	1730	1280								
KLC 4 coal (free-leach)	pH	8	7.83	7.80	7.78	7.88	8.00	7.77	7.92	7.69	7.42	7.17	7.46
	EC	1480	2110	1790	1840	1550	1530	1300	1260	1090	1170	1160	1010
KLC 5 floor (saturated)	pH	8.21	7.69	7.96	8.02								
	EC	760	891	720	531								
KLC 6 floor (free-leach)	pH	8.01	8.12	8.06	8.15	8.21	8.24	8.13	8.17	8.12	8.07	8.13	8.08
	EC	1150	1080	967	618	537	414	391	363	308	310	301	251

5.7 Conclusions

RGS has completed a soil fertility, geochemical, and physical assessment of mine materials (overburden, coal, coal roof, coal floor, and soils) to inform relevant application conditions for an EA amendment and PRCP for Broadmeadow East Project. The main findings of the geochemical assessment are as follows:

- The majority of the waste materials have low sulfide content, excess ANC, and are classified as NAF (**Section 5.1**). These materials have a very low risk of acid generation and a high factor of safety with respect to potential for generation of acidity.
- There is no significant metal(loid) enrichment measured in whole rock analysis using a 2 acid Aqua Regia digest in the samples compared to median crustal abundance in unmineralised soils (**Section 5.2**).
- 52 major ions and metal(loids) were analysed for by ICPMS using a 1:3 – 16 hour water soluble shake flask extraction method (**Section 5.2.2**). Elements at concentrations above 1 mg/L include Al, B, Ba, Ca, Fe K, Mg, Mb, Na, and Sr. Other elements including Al, As, B, Ba, Ca, Ce, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo Ni, Pb, Rb, Sb, Se, Sr, Ti, V and Zn were also in the water soluble fraction at 0.01 to 1 mg/L. Water soluble elements at concentrations in overburden greater than 1 mg/L include Al, B, Ba, Ca, Fe, K, Mg, Na, and Sr.
- Initial and ongoing surface runoff and seepage from waste rock and coal materials is expected to be circum-neutral to mildly alkaline, have a low salinity, and low dissolved solids (**Sections 5.4** and **5.6**).
- Baseline values have been obtained to be used as rehabilitation criteria for the Project (**Section 9.2**).
- Mine material characterisation should be continually assessed throughout operation.
- The geochemical assessment of mine waste materials (specifically **Sections 5.3** and **5.4**) has provided information to aid the development of the landform evolution and landform stability for the Project (**Section 6**).

6 Landform evolution and landform stability

Natural landforms evolve over millennia. Constructed mine landforms on the other hand are created in years.

The Project construction period will be in the order of 7 years. As constructed mine landforms evolve, they undergo accelerated rates of physical, chemical, and biological weathering until they attain equilibrium with the surrounding landforms.

Constructed mine landforms can have significantly different topographic, geochemical, and physical attributes to the pre-mine landform. The ecological functions that the constructed mine landforms need to serve, to attain long term stability must be amenable to the new landform i.e. if the pre-mine topography was seasonally inundated with floodwater and the local vegetation and land use accommodated those conditions, will large external waste dumps constructed tens of metres above the groundwater table be able to serve the same ecological functions, or will the ecological capability and functions of the new landform need to change as well?

6.1 Scope of this section

This section of the mine material assessment and land stability report:

- includes a technical discussion of natural landform evolution including soil and regolith development
- evaluates the stability aspects as they relate to the constructed mine landforms in the Project area
- contains a forward work program summary that is proposed to be put in place to provide a pathway to achieve landform stability of the constructed mine landforms.

Aspects that need to be considered relating to rehabilitation and therefore landform stability include the following:

- Proposed construction and management of the final landform
- Factors relevant to the final landform (i.e. soil characteristics, landform design, controls, etc.)
- The presence of reject coal, that may provide a source of contaminants that could be mobilised
- Risk of sodicity, erosion, and sediment and control
- Post-closure flooding impacts of diversions
- Post rehabilitation management
- Spoil management
- OOPD design
- Residual voids
- Rehabilitation objective
- Progressive rehabilitation and closure

This section concludes by assessing the potential risk of adverse impacts to the downstream environment and, provides further recommendations to manage mining operations to avoid adverse impacts to the downstream environment.

6.2 Landform stability

Landform stability has traditionally been considered in terms of geotechnical stability. In this report, landform stability has been evaluated in terms of:

- geotechnical stability and the potential for slips, slumps, or major slope failure
- geochemical stability and the rate at which major ions (salts), metals (such as aluminium, copper, and zinc) and metal(loids) (such as arsenic, molybdenum, or selenium) may be leached from or sorbed to geological materials (this report)
- surface stability that determines if the soil profile is likely to aggrade or erode and whether the soil profile can retain its ability to support vegetation
- hydraulic stability that might consider if the soil: water balance within the strata is in equilibrium with the vegetation or the way water moves through the strata
- ecological stability and post mine land use to determine whether the vegetation on rehabilitated land will be stable or change over time due to processes such as successional development.

6.3 Landform stability assessment

This landform stability assessment addresses the final out of pit and backfilled spoil dumps that will exist above pre-mine topography at closure.

The operational aspects of the management of the waste rock dumps are addressed through implementation of the soil, water, and sediment and erosion control management strategies.

The landform stability assessment includes two components. The first is the stability of the as-placed mine materials within the waste rock dump, and the second relates to the stability of the reinstated soil cover system.

6.4 Mine planning and rehabilitation schedule

This open cut coal mine is a truck and shovel mining operation with a 5 to 7-year mine life and an allowance for 1 year of final rehabilitation activities. Progressive rehabilitation will begin in the second to third year of operation.

6.4.1 Design goals, design objectives, design criteria and performance targets

A complete list of rehabilitation goals, design objectives, design criteria, and performance targets are in the EA submission.

6.4.2 Mine domains

A summary of the approximate area of the mine domains and additional information relating to the mine plan for the Project is in the EA submission.

6.4.3 Mining sequence

Xenith Mining Consultants (Xenith) (2021) produced the general mining sequence, sequential mining sequence, and final rehabilitated landform for the Project.

The truck and shovel mining method will be employed as the means to extract the resource from this entirely surface mining operation. The truck and shovel method is the most flexible for various mining situations including smaller deposits, as is the case for this Project. The high capital investment required for dragline equipment is not necessary for smaller deposits as it does not require the high productivities gained through using this equipment.

During the construction stage, the trees and shrubs will be cleared, grubbed, and stockpiled using a combination of scrapers and dozers. Where possible, the stockpiled vegetation will be placed on completed rehabilitation areas to encourage the re-establishment of microecosystems. After the vegetation is cleared, topsoil will be completely stripped using dozers from the out of pit dump areas and the progressively stripped from mining areas as operations progress. Where possible, the topsoil will be stockpiled adjacent to the

OOPDs to avoid double handling and haulage as well as be available for progressive rehabilitation within the first two years of operation. Clearing of the pit area will occur progressively to preserve the topsoil and reduce erosion potential. Topsoil that cannot be stored adjacent to the out of pit dump and pit area will be relocated to the south of Hat Creek (north of the pit) using front end loaders and dump trucks.

After areas are cleared, the overburden will be removed and placed into the out of pit dump initially. Coal mining will commence once sufficient overburden is removed. The target coal measures dip to the east and the steepness of this dip will dictate the type of equipment that operates on the seam roof and floor. Mining will commence on the northern end of the deposit and proceed in a southerly direction along the strike with the strip laid out down dip in a method known as 'terrace mining'. The pit is excavated in a series of horizontal terraces which in turn exposes the coal and waste on every bench. Augers will be used to extract any coal resource exposed along the highwall.

The overburden will initially be dumped out of pit then backfilled in pit when sufficient dump room becomes available by the end of the first year of operation. Backfilling is a feature of truck and shovel operations which refers to the waste being hauled and dumped back to previously mined out areas. This method seeks to take advantage of shorter haul distances through the creations of bridges across the strip to transport waste from lower benches to the dumping area. The backfill is often keyed into the highwall in this process. While multiple waste haul roads are required to link the terraces to waste benched, haul cycle times for removal are reduced through the removal of the vertical component of the haul.

6.4.4 Mining schedule

There is an annual mining and mine placement schedule for the project to specify material movement. The cumulative volume of excavated waste from open cut activities is expected to include approximately 103.8 million loose cubic metres (Mlcm) consisting of spoil, subsoils (i.e. those subsoils which are not suitable for mine rehabilitation) and reject coal. Approximately 22.4 Mlcm of spoil materials to be stored within the OOPD beyond the maximum extent of the pit rim on unmined ground. Spoil materials generated during the mining operations will be emplaced within either: OOPD (particularly during the initial development of the open cut pits) or backfilled within the completed mining areas.

The waste rock stockpiles to be developed during the initial open cut activities will be temporarily/progressively rehabilitated (including the installation of appropriate water management structures) to assist with the management of erosion. At the completion of mining operations, materials temporarily stored within these spoil stockpiles will be used to fill the completed mining areas. At this time, the remaining materials within the OOPD will be reshaped, covered with subsoil and topsoil, and rehabilitated to achieve the final landform design.

Reject coal (if it is encountered during mining) will be co-disposed with spoil materials within the OOPD and within the pit. These materials will be disposed in locations well below the elevation of the final landform design. Exposed coal on the pit floor and pit walls will contribute to solutes in the final void.

Table 6-1: Proposed mining schedule by period

Year	Volume (Mbcm)*	Accumul-ative Total (Mbcm)	In-Pit Dump (Mlcm)*	Ex-Pit Dump (Mlcm)	Ex-Pit Pit-2 (Mlcm)	Ex-Pit Pit-1 (Mlcm)	CHPP Total Reject (t)**
P1	10.3	10.3	0	10.5	3.4	7.1	428,346
P2	14.1	24.4	9.7	5.9	4.6	1.3	418,752
P3	13.7	38.1	10.8	4.7	4.5	0.2	391,778
P4	13.5	51.7	15.4	0.1	0.1	0	336,360
P5	13.3	65.0	15.1	0	0	0	390,363
P6	14.5	79.5	16.3	0	0	0	356,548
P7	3.4	82.9	3.5	0	0	0	280,379
Total	82.8	-	70.8	21.2	12.6	8.6	2,602,527

*Million bank cubic meters (Mbcm) *Million loose cubic meters (Mlcm)
**tonnes (t)

6.4.5 Rehabilitation schedule

The SGM (2021) and RGS soil assessment (**Section 2.3.2**) calculated stripping depths and material balances from the proposed pit shell that allow for 1.3 M lcm of topsoil and 9.9 M lcm of subsoil. The available volume from the proposed strip depth fulfills the projected material requirement for rehabilitation. The material balance provided above includes the topsoil and subsoil material balance that could be won from stripping the out of pit waste dumps before mine material is placed on them.

6.4.5.1 Landform design

It is estimated that approximately 743 Mbcm will report to the two OOPDs. The area occupied by Western OOPD and Eastern OOPD will be 43.6 ha and 60 ha respectively.

Western OOPD will initially be developed up to RL 150 m and be reformed to a maximum final landform height of RL 346 m upon the completion of mining operations.

Eastern OOPD will initially be developed up to a maximum landform height of RL 346 m and will be reformed to a landform height of approximately RL 100 m at mine closure i.e. 45.3m in height assuming the pre-mine elevation is approximately 30 m RL.

The final landform design of Western OOPD and Eastern OOPD will be refined throughout the mine life to ensure that the landform established will be stable, safe and support the intended final land use (i.e. low intensity cattle grazing) for the Project area.

6.4.5.2 Backfilling open pits

The Project propose to retain one minor open cut pit (or void) at the northern end of the final landform, and a larger open pit (void) at the southern end of mine at closure. The spoil materials which are temporarily stored within the ‘in pit’ and ‘out of pit’ stockpiles could be available to backfill the completed open cut pits to the final landform design if this became necessary.

Backfilling open pits is consistent with best industry practice and may negate environmental issues associated with the presence of final voids and the development of pit lakes. Backfilling of the open pits will proceed progressively over the life of mine. Backfill material will include overburden and reject coal. The physical properties of these materials and their distribution through the backfill will influence and in some instances control the overall stability of the structure. The Projects open pits are shallow (relative to other coal open pits) and the geotechnical issues associated with slumping or failure of the in-pit end tipped slopes will be managed using standard industry practices.

The geochemical analyses of the mine materials including reject coal have determined that the environmental risk of the samples is low (**Section 5**). The environmental aspects of backfilling mine materials to the open pits over the mine life are the effects related to the potential oxidation, weathering, and leaching of salts and metal(loid)s from the mine materials to the toe of the tip head and into in-pit dumps. During mining operations, the in-pit water will be pumped into the mine water dams. As the backfilling process proceeds the backfilled material will be subjected to loading and settlement that will consolidate the backfill materials.

The open pit decreases in depth from south to north. Water accumulating in the southern void, may therefore percolate through the backfilled spoil to the north, unless the PSD is dominated by fines that upon consolidation would become increasingly less permeable.

In cases where backfilling into mined pits is followed by reshaping and rehabilitation, settlement at the surface can lead to the formation of depressions in the contour drain that subsequently lead to ponding and then overtopping of the drain during rainfall events which potentially may lead to scouring and erosion.

Landform stability issues associated with backfilling mine waste to the mined open pits is likely, as the short mine life does not allow for “years” of loading and settlement of the backfill material prior to reshaping to final landform design. Reshaping and iterative repairs may be required until landform stability is attained.

6.4.6 Temporary landforms

All mined material will be placed into a final constructed mine landform, and there will be a minimal requirement for reshaping.

6.4.7 Chemically reactive material

Identifying and selectively utilising mine materials with low sodicity will be important for the temporary and final shaping and rehabilitation of the OOPDs. Materials characterised and validated as non-dispersive and non-sodic will be used for the outer slopes of waste rock stockpiles to limit the potential for dispersion and erosion, with identified sodic materials disposed of within the central (inner) zones (i.e. below the final landform design) of OOPD.

Spoil materials that are sodic (or have other geochemical constraints) will be selectively handled and disposed deep within the mining area or within the core of the OOPD (i.e. in locations which are well below the final landform design). Sodic material has been identified from the GaPSaAP (**Section 5.4**), but the majority of topsoil and subsoil units have a low potential for dispersion (**Section 5.4.4**).

PAF or sodic material will not be placed near the surface of the temporary (or designed final landform surface) of the OOPD. If any such material is identified, the material will be picked up and end tipped to the open pit otherwise the area will be capped with geochemically and physically inert material prior to top soiling and seeding. The only PAF material identified from the GaPSaAP is associated with non-economic coal, and this should only represent a very small proportion of the overall mine material balance.

As discussed above, the impact of PAF, saline, or sodic material would be the leaching of salts through the backfilled material into the mined void and then to the deepest mined surface (pit floor) and pit dump during mining and then to the pit lake post closure.

The adverse effects of the placement of reactive mine materials into the pits will be low (i) because the geochemical analyses indicate the geochemical risk of the samples is low and (ii) the groundwater quality within most areas of the mine pits is moderately or highly saline.

RGS has not addressed the potential for spontaneous combustion.

6.4.8 Beneficial use of non-reactive material

As the project evolves and detailed designs are developed, it will be possible to define the surface extent of the final landform surfaces. With this knowledge, it may be possible to selectively place geochemically low risk (non-sodic) regolith materials in these zones i.e. construct zones within the temporary landform design to final design. This will have the added benefit of building extensive areas of the stockpiles to conform with the natural soil and regolith profile.

The soil assessment (**Section 5.3**) has verified that the Dermosol soil units from 0 m to 4 m bgl l and the Kandosol soil units from 0 to 1 m bgl have extremely low dispersive potential. These units should be reserved and used in areas where there is a greater potential for erosion i.e. on external slopes.

6.4.9 Rock mulching

The OOPD to be developed during the initial open cut activities will be temporarily stabilised (including the installation of appropriate water management structures) to assist with the management of erosion. The process to achieve temporary landform stability (limiting erosion) will be to rock mulch the external stockpile faces and the temporary upper landform terraces of areas that may be susceptible to erosion with competent and durable rock. Rock mulching is routinely used on landforms to increase surface roughness, encourage containment and percolation of surface runoff to achieve landform stability. Rock mulch will be sourced from competent overburden and used opportunistically from resources that have been identified within the pit (**Section 5.5**).

The capacity to implement this rock mulching process will be dependent on the ability to source adequate volumes of suitable material over the life of the mine. The physical sampling and analysis completed to date verify that there is competent and durable rock within the overburden units available for this construction use (GTS, 2021).

6.4.10 Stakeholder expectations

Increasingly, stakeholders and regulators are requiring objective assessments of landform stability over longer time periods. Given the financial and environmental liability that is associated with constructed landforms, such assessments are in the best interests of both regulators and the mining industry.

The Queensland Government approach to addressing these financial, and environmental issues is for projects to develop a PRCP.

CCO has the geological information and mine planning principles in place to develop a PRCP for the Project that will meet the requirements of DES.

CCO will engage in ongoing community consultation as per the requirements of the PRCP.

6.4.11 Principles of landform design[1]

The following principles of landform design are consistent with the values being developed for the Project and conform to leading industry practice.

1. **Begin with the end in mind.** Create a shared vision for the reclaimed land among the mine, its stakeholders and work together to earn each other's trust.
2. **Establish governance**. Assemble a multidisciplinary design team and appoint a lead designer.
3. **Set clear land-use targets, goals, design objectives, and design criteria** in a Design Basis Memorandum. Support the vision. Anticipate the land will evolve over time — physically, chemically, ecologically, and socially. Design and maintain the land to adapt to these changes, including those driven by an ever-changing climate.
4. **Work collaboratively in every endeavour**. Build the reclaimed landscape *with* (not *for*) the land's users.
5. **Work all spatial scales** — regional, landscape, landform internal and external), element — simultaneously.
6. **Design for construction and operations**. Landforms and landscapes should be easy to build and reclaim using available technology that is fit for purpose. Control the source of contaminants. Avoid producing soft tailings.
7. **Use a risk-based approach**. Design for the most reliable or most likely case. Embrace the observational method and true adaptive management. Enact predetermined contingencies as needed to allow the evolving land to perform as intended.
8. **Follow every drop of water through the landscape**. Water is both a key to life and a great agent of disruption.
9. **Know your materials**. Cover and revegetate all mine waste. Ensure adequate borrow. Conserve soils.
10. **Favour progressive reclamation**. Learn by doing and document achievements. Ensure timely access to reclaimed land. Collaborate for progressive signoff. Minimize the work required after the last tonne of ore is mined and the mill shuts down.
11. **Acknowledge the land will revert to the local community** and support their duty of stewardship. Reclaim every square metre. Avoid unnecessary long-term care but anticipate where it will be required. Provide full financial assurance for all phases of mine life.

6.4.12 Typical failure modes

Constructed mine landform designs for waste rock dumps can range from linear slopes and hard engineering approaches using berms, and batters and drop structures through to the application of curvilinear / concave profiles and in some cases complex geomorphic design principles that strive to conform with local landscape geomorphology.

Major risk factors for degradation or failure of constructed landforms are extended slope length, high slope angle (including uniform or convex slopes), upslope catchment, ponding of water, permanent erosion control structures, high clay, silt, and fine sand contents, sodicity, dispersion, and a low or non-resilient fragmental

[1] Sourced from Canadian Landform Institute. http://landformdesign.com/about.html

content (Emerton et al., 2018). Where failure is present on these material types, it appears as poor or patchy plant cover, capillary rise of salts, piping, sheet and gully erosion, and failure of designed erosion control structures (Emerton et al., 2018).

Erosion is the end point of failed land stability. The potential for erosion to occur can be evaluated through geochemical and physical sampling and analytical programs (GaPSaAP) to quantify the properties of the materials and subsequently (i) the use of the samples in field trials to measure erosion or (ii) the application of the measured data using numerical modelling methods to infer erosion potential.

Landform design evaluation methods using numerical modelling have advanced considerably over the last 10 years. It is now possible to use various runoff/erosion models to develop site and material specific landform designs that are demonstrably stable in the medium to long term, and to consider a wider range of rehabilitation goals. However, these modelling methods (e.g. CAESAR, SIBERIA, WEPP, RUSLE) are constrained to the evaluation of erosion from the surface material. While these landform modelling tools provide an estimate of landform evolution, using field measured data to determine if the design objectives are being met is preferred.

Constructed slopes designed with traditional planar cross sections are encountered in most land development, including highway cut and fill sections, constructed embankments, and reclaimed mine lands. However, planar landscape profiles are seldom encountered in nature. Curvilinear slopes with concave shapes usually arise as the result of evolutionary processes in fluvial systems and hillslopes (**Figure 6-1**).'

The Project propose to reduce the potential for adverse effects and failure modes related to landform design by using very low slope angles (1:7 slopes). The low slope angles coupled with the beneficial chemical and physical properties of the soil and subsoil that is available from within the project area will provide beneficial outcomes for initial landform design and long term performance.

6.4.13 Landform design considerations

Landform design approaches such as the geomorphic reclamation of mine lands (Toy and Chuse, 2005) include the construction of concave shapes in both the transverse (cross-slope) and longitudinal (downslope) directions to create natural self-sustainable ecosystems (Martín-Duque et al. 2010) with improved erosion resistance (Schor and Gray 2007). Hancock et al. (2003) studied a series of linear and concave landforms on mine spoil in northwest Western Australia. His study demonstrated that over the range of slopes and slope lengths examined, concave slopes can reduce sediment loss by up to five times that of linear slopes.

Although there is evidence to verify that concave slopes yield less sediment from erosion than planar slopes (Hancock, 2003, Priyashantha et al., 2009 and Jeldes et al., 2016) not all concave shapes are mechanically stable. For example, Howard et al. (2011) point out the risk associated with the practice of shaping slopes to reflect natural regional landforms without appropriate material characterisation (Emerton *et al*., 2018) and stability and erosion analyses and without accounting for the limited precision of the construction equipment employed to build concave profiles can lead to erosion and slope failure. The outcome of the extensive bodies of work related to landform design and landform stability are that each site should be evaluated on its own merits and standard approaches should be avoided.

CCO have included an area within the site that will be profiled to final landform design by Year 3. This commitment will enable CCO to evaluate a range of landform design profile and surface treatments that can be applied to the later stages of project development. The development of site-specific landform design principles are consistent with authors including Howard et al (2011) and Emerton et al (2018).

Detailed landform designs integrated with the mining schedule will enable the projected final landform surface to be defined. Throughout the mine life, material can be placed on the contact of the final landform surface to attain final landform design principles i.e. deep layers of regolith units could be placed on this contact so what when the temporary material placed above it is pushed down or moved the exposed material will be suitable as the basal layer of the final rehabilitation layer.

Building on this material placement approach, and acknowledging that the long-term landform evolution process is likely to lead to a curvilinear slope with concave shapes, the placement of the "regolith" units could be done so that a greater depth of material is placed on the shoulder, backslope and foot slope e.g.,

- 2 m of regolith material could be placed on the summit,
- 5 m of regolith material could be placed on the shoulder,

- 10 m of regolith material could be placed on the backslope
- 2 m of regolith material could be placed on the foot slope
- 1 m of regolith material could be placed on the toe slope as material eroding from higher on the slope with aggrade in this zone.

The RGS test pit work in this assessment, the geotechnical drilling by GTS (2021), and older geological drilling verify that the topsoil and subsoil profile includes soil, sand and clay lenses up to at least 6 m bgl. These soil units are underlain by a deeply weathered regolith profile in the project area (although it is variable in material types) is nevertheless deep (in the order of 20 to 25 m in depth) and consistently dominated by clay, silt and sand size fractions. These findings verify there will be the potential to construct deep regolith profiles as a component of the final landform design.

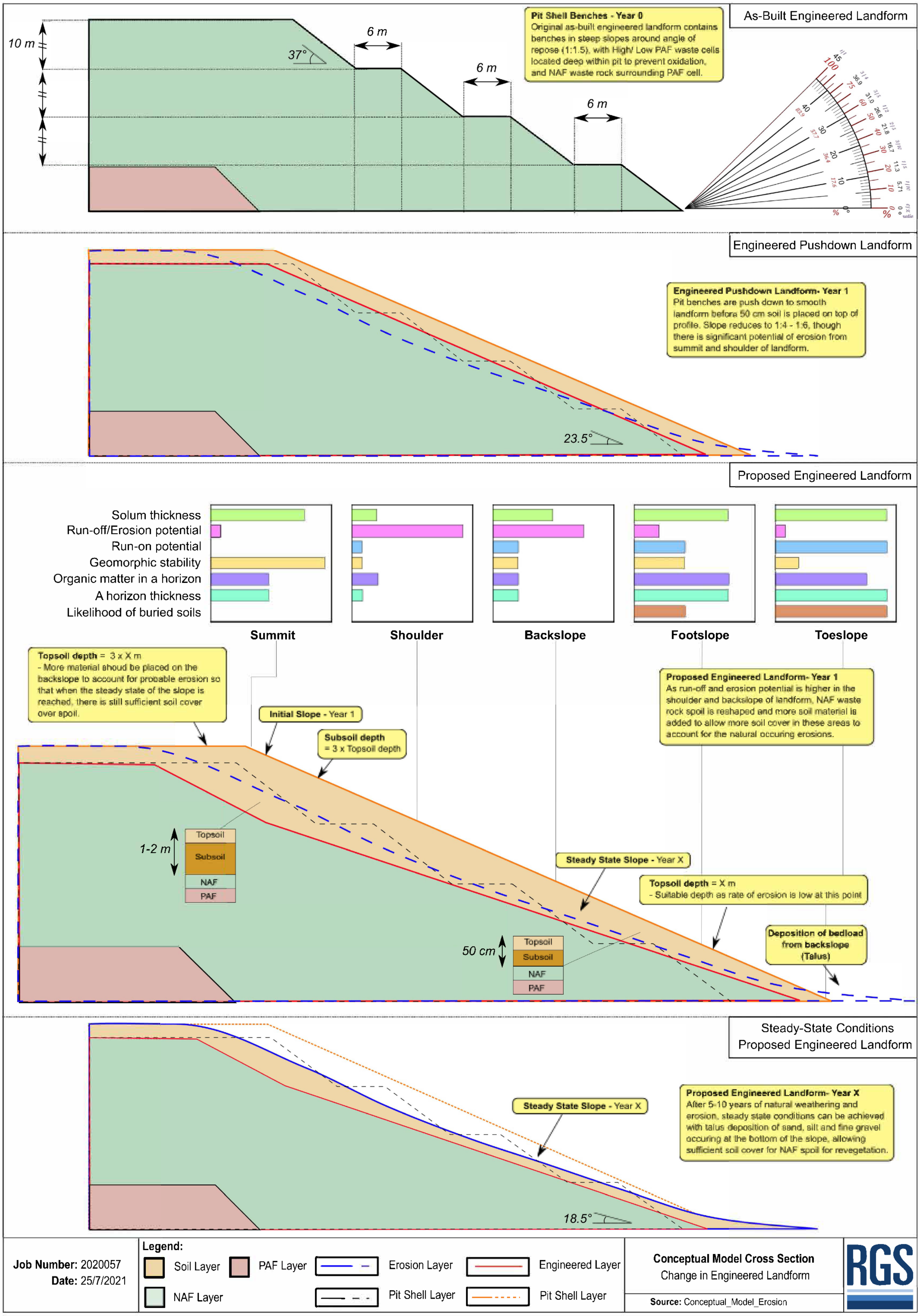

Figure 6-1: Effects of hillslope position on soil properties in a humid climate. (After Schaetzl (2013))

6.4.14 Landform profiling to final design

General landform design considerations from Hawley and Cunning (2018), being incorporated into the final landform design (**Table 6-2**) are that the as-built final geometry should resemble a mature landform, which involves measures such as the following:

- designing the final landform using natural analogues
- avoiding benches, terraces, contour banks and abrupt changes in topography
- avoiding man made materials (e.g. gabions)
- using a spur end shape in plan view with a concave-convex profile if feasible
- providing appropriate distribution and quantity of drainage features (that are a function of climate, soils and slope)
- situating watercourses in valleys as opposed to banks
- establishing vegetation progressively.

Table 6-2 Summary of Design Criteria

Mine domain	Proposed Criteria
Overburden dump outer slope areas	
Vertical distance between berms	20 m
Berm width	5 m
Overall slope angle	15.0%
Drainage direction	Outward away from void towards original topography drainage paths
Overburden dump inner slope areas	
Vertical distance between berms	20 m
Berm width	5 m
Overall slope angle	12.0%
Drainage direction	Outward away from void towards original topography drainage paths
Final void areas	
Vertical distance between berms	20 m
Berm width	5 m
Overall slope angle	15.0%
Final pit walls - Competent material	70 degrees
Final pit walls - Incompetent material	45 degrees
Underwater slopes	Angle of repose 37 degrees
Drainage direction	Into void
Complete backfill level	Original topography
Partial backfill level	Above ground water level

Where possible, spoil dumping should be planned to minimise material rehandling, controlling closure costs. The top surface should be sloped and minimised to reduce the potential for ponding and the accumulation of water that must be removed without causing erosion.

The proposed final landform design (**Table 6-2**) adheres to industry leading practice with maximum backfilling of final voids and minimal open final voids that that will be classified as ephemeral water storages, very low slopes, and no large flat areas on the top of the constructed mine landforms.

Detailed landform design process will verify how the temporary landforms will progress to a final landform design. Assumptions relating to how this can be managed are in **Section 6.4.6**.

6.4.15 Soil stripping, stockpiling, and reclamation

The topsoil and subsoil and the deeper regolith to about 25 m bgl within the open pit footprints ranges from having very low to high salinity and sodic potential in surface Chromosol units and deeper Kandosol units.

Based on stripping depths by SGM (2021), the available material balance of topsoil and subsoil is sufficient for landform rehabilitation. Maximising the stripping depth wherever possible should be encouraged to increase the available material balance.

Stripping and stockpiling of soil prior to its use in rehabilitation programs inevitably leads to soil loss and soil degradation over the mine life: a 10% soil loss is accounted for by SGM (2021) and in the rehabilitation schedule. Soil removed early in the mine life will be stockpiled for up to five years before it is utilised on final landforms for rehabilitation. From the third year of operation, topsoil will be used during progressive rehabilitation.

Reclaiming sodic soils is primarily achieved by leaching sodium chloride from the soil to decrease the soluble and exchangeable sodium percentage (ESP), typically with mineral supplements such as powdered dolomite that contains calcium and magnesium or powdered calcium carbonate. But this approach may oversimplify the facts and limits the reclamation process to one aspect without considering hydraulic and biological aspects. For example, Dieleman (1963) and Leffelaar and Sharma (1977) reported that an amendment may not be needed for reclamation of saline soils having high sodium adsorption ratio (SAR). They found that the decision to use a chemical amendment for the reclamation of saline soils having excess neutral soluble salts and a high SAR of soil solution (the so-called saline-sodic soils) would depend on soil infiltration characteristics and the electrolyte level of the irrigation water. Light textured soils and those having a favourable infiltration rate are not likely to respond to gypsum application: light textured soil with a high silt and sand content are a probable feature of the material that will be present below the final subsoil and topsoil. In heavy textured soils, and where such soils are leached with low electrolyte water, application of an amendment is desirable to hasten reclamation. Given the favourable chemical and physical attributes of the soil profiles (**Section 5.3** and **Section 5.4)** chemical amendment to mitigate sodic issues is considered unlikely.

6.4.16 Re-establishing the soil profile

The reconstructed landform profile includes five components:

- Foundation material (natural ground or deepest mined surface)
- Basement material (overburden, interburden (claystone, siltstone, and sandstone)) and coarse and fine rejects
- Regolith (sand, sandy clay, clay units)
- Subsoil (B and C horizons)
- Topsoil (A and B horizons)

The constructed soil profile will be built on the basement material e.g. emplaced overburden and interburden comprising claystone, siltstone, and sandstone.

The physical attributes of the basement material have been quantified and found to range from low to high rock strength using point load and uniaxial analytical methods (GTS, 2021). The physical attributes from the measured data can be applied to the strata within the Projects geological database to construct a detailed geological model (and in time material balances for units such as competent sandstone to be used for rock armouring). When this work is done as a component of the PRCP in a detailed mine schedule this will then enable the location, volume, and probable performance of the strata in the stockpiles to be determined. The outcome of this analysis will be that competent durable strata will be able to be identified and segregated for specific applications such as armouring temporary end tipped stockpiles faces.

The geological and modelling information outlined above (and the information discussed in **Section 6.4.13**) will make it possible to place regolith strata (or other specific strata recovered during mining) on what will become the final landform surface contact so that when the temporarily stockpiled overburden and interburden material is removed the basement unit on the final landform (the regolith strata) is already in place. There is a substantial volume of regolith strata available for this purpose verified by geotechnical drilling and logging from the Project historical and GTS (2021).

When the final landform basement material (that may comprise recovered regolith strata or as mined waste) is uncovered and profiled to conform to the final landform design criteria, the secondary media (subsoil) material will be placed over the basement unit. The material balance estimate for the secondary media (subsoil) is based on the root zone depth below the topsoil stripping depths identified from soil profile descriptions by SGM (2021). Sodicity, salinity and dispersive behaviour of this material may constrain its use, however soil remediation using leaching and or gypsum will reduce any adverse effects related to sodicity. Under the proposed rehabilitation process subsoil will be placed below topsoil thereby reinstating baseline soil profile conditions to enable sustainable growth of vegetation.

The upper component of the soil profile will be primary soil media (topsoil). Low soil fertility, particularly available phosphorous, was defined as a limitation to topsoil fertility (SGM, 2021), however the measured values nonetheless support the existing vegetation and land use so the measured values representing baseline conditions should not be a constraint, unless the stockpiled soil lose carbon and nutrient content during stockpiling. If the loss of carbon and nutrient content does occur these impacts can be overcome during the rehabilitation process.

The soil material balance specifies that there is the capacity to spread approximately 500 mm of topsoil and > 2500 mm of subsoil on the reshaped waste rock stockpile slopes. It is assumed that the subsoil will be hauled from the stockpiles to the top of the dumps and will be pushed down the slopes using graders or dozers and that the topsoil will be placed over the subsoil.

Placement of rock (nominally 150 to 300 mm PSD at approximately 10 to 20 % surface coverage) and deep ripping through the topsoil and subsoil along contour can be evaluated as a method to slow and intercept surface runoff and reduce overland flow.

Soil development is intimately tied to the slopes on which soils form. Soils across and down slopes are connected, process-wise, like links in a chain: this analogy has led to the concept of a “catena” – a term for a series of soils on a slope (Schaetzl, 2013). Inclusion of these processes are important to consider in the rehabilitation process because fluxes of sediment, commonly facilitated by water, vary predictably as a function of position on the slope, leading to soils that may be thinner or thicker than expected on steep slope segments where runoff is accentuated (**Figure 6-1**). Conversely, soils on lower, flatter slope segments may be overthickened from many years of slow but episodic sediment accumulations from upslope; when sediment accumulations are particularly fast or large, soils here can become buried.

Soil texture and infiltration capacities dramatically impact these processes; on slopes composed of coarse, more permeable materials, catenary position is less important because there is less runoff, and thus, even on the steepest slope segments, much of the water infiltrates vertically. Water tables, commonly deepest on the steepest slope segments, vary predictably as a function of position on the slope. Shallow water tables can dramatically affect internal soil processes, as well as weathering and related phenomena, although it is noted that groundwater is typically greater than 10 m below ground level (refer to Chapter 10 of the SEIS).

6.4.17 Re-vegetation and final land use

RGS support the use of a cover crop to stimulate the accumulation of carbon, organic matter and nutrients in the topsoil and subsoil horizons as this this assist in improving soil texture and structure and reduce the effects of sodicity.

A carefully managed grazing land use is likely to have significant benefits for the long-term stability of the constructed mine landform that could include recycling nutrients through the soil profile.

6.4.18 Surface water management of the final landform

The majority of the mine waste will be contained within the footprint of the backfilled void. This is a beneficial outcome of the landform design because it will lead to almost all of the soluble major ions and metal(loids) percolating through the mine waste into the backfilled voids, rather than as seepage from the toe of the dumps onto the natural (un-mined land) land which subsequently runs off into the two adjoining creeks.

Stripping of topsoil and subsoil from the footprints of the two out of pit dumps could be done so that these areas drain back towards the mine pit at 5%. This will ensure all water, salts, and metal(loids) leached from the mined materials in the out of pit dumps ends of in the mine void.

One of the failure modes that leads to erosion is the ability of a rehabilitated landform to manage surface water during rainfall events. Typical landform design options include linear slopes or linear slopes with (temporary or permanent) contour drains that direct runoff to drop structures. Alternative designs can include building slopes that are more like natural slopes i.e. curvilinear / concave slopes. There are three key failure mechanisms that can occur to engineered water drains (i) the drain fails due to a structural flaw or poor implementation of the design and / or (ii) the materials used to construct the drain weather in an unexpected way affecting their integrity and /or (iii) settlement of the landform occurs rendering the design objective obsolete i.e. the land settles and a contour drain sinks, pooling water instead of draining the water from the slope, leading to overtopping of the pool across the top of the contour berm, followed by erosion, breaching and failure that in most cases leads to gully erosion. Development of the final landform and drainage structures will take into account and design to avoid these potential failure mechanisms.

Contour grooving, channel linings, rock mulching and drop structures will be constructed on the outer slopes to prevent long watercourse runs and minimise slope erosion. The proposed mine water management system has been designed based on water balance modelling to contain runoff from mining disturbance within the site during the Surface Water Impact Assessment (SWIA) process. During wet climatic conditions, releases from the mine water management system from the proposed release point (MAW dam located adjacent to the MIA (north)) are proposed to occur. Based on the measured geochemical data environmental release of water is expected to result in negligible impacts on downstream water quality and are to remain within the range of natural variability (Engeny, 2021).

6.4.19 Groundwater management of the final landform

Over the mine life flood water has a low potential to enter the site and inundate the external waste rock dumps, open pits and backfilled pits. Surface water inundation will be managed with flood levees in place during mining operations. Subsurface flow could occur through the regolith during flood events, but because of the low incidence of these events the actual flow rates would be quite low. From a long-term closure perspective, the backfilled voids will store a substantial amount of water. The water will saturate the backfilled spoil including the reject coal. The presence of carbon and sulfur in the mine waste will lead to anoxic and reducing conditions leading to the immobilisation of sulfate and most metal(loids). Therefore, the effects on groundwater quality should remain within pre-mine baseline conditions.

6.5 Forward works and recommendations

The technical work for this project will continue during the subsequent stages of project development. The ongoing work will fill existing technical gaps and be used to develop the mine to a detailed design stage that can be subsequently compiled into a PRCP for the Project. RGS recommend that CCO implement the following staged sequence of work.

- Utilise the Project’s existing geological model and geological logs to identify the major strata including the soil and regolith and overburden and the interburden e.g. topsoil, subsoil horizons, alluvial or colluvial lenses, regolith, extremely weathered to weathered rock units in the overburden and the subsequent fresh rock units in the interburden. Refine the geological model to include these major geological strata.
- Use the geological and GaPSaAP data to develop a combined geo-environmental stratigraphic model (GSM). This type of model simply adds layers to the geology model to document the areas covered by the major soil types and depths for topsoil, subsoil and the depth of the regolith to the base of weathering to enable reliable calculation of the material balance.
- Use the GSM to verify the material balance that is available for each of the major geological units in the deposit and use this information to verify key landform design criteria.
- Build the GSM into a detailed landform haulage schedule (LHS) that can be used to compile a complete and detailed life of mine plan.
- Use the GSM and LHS to optimise the construction and rehabilitation sequence.

7 Conclusions and recommendations

The geochemical assessment completed by RGS found that the samples analysed for this report are classified to have a low risk of acid generation, no significant metal/metalloid enrichment, low levels of salinity, and therefore have a high safety factor and low residual risk (**Section 5.7**). Selective handling may only be required for non-economic coal that is mined and place in the pits and sodic soil units.

The land stability assessment completed by RGS found that the topsoil, subsoil and regolith chemical and physical properties combined with the proposed very low slope angles and ability to direct surface runoff from the constructed landforms to water dams or the small residual voids will provide beneficial outcomes for rehabilitation at this site.

RGS recommend the following be undertaken for the Project:

- Soil reclamation methods should be evaluated in site specific trials and refined as early as possible to inform large-scale reclamation, the need for application of amendments and their quantities.
- At surrender of the lease the final landform will have been in place for up to 7 years in some areas, but as little as 1 year in other areas. Settlement and consolidation of the foundation materials in the backfilled pits will therefore be variable. Settlement of the landform may affect surface drainage features and an allowance should be made to reinstate or repair drainage features until surface stability is attained.
- Evaluate the proposed final land use methods as early as possible in the mine life to verify that early rehabilitation areas are fit for purpose.
- Maximise use of non-sodic and non-saline Dermosol and Kandosol for surface soil units in rehabilitated areas.
- Ensure the reinstated soil profile include at least 0.4 m of topsoil/subsoil (as recommended by SGM, 2021), and additional subsoil / regolith material that is dominated by fine drained (< 2 mm PSD) material where reinstatement of 3 m depth or more is required (refer to **Figure 6-1**). This additional unit in the reinstated soil profile may be unconsolidated clay, silt and sand from run of mine waste, or stockpiled regolith.
- Understanding of long-term landform evolution should be considered in the design i.e. soil depth may need to be deeper in the middle of the linear slope as this area of the slope will undergo the most erosion over time as the landform moves from a linear to concave slope.

8 References

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9 Attachments

9.1 Attachment A: Geochemical Methods and Assessment of Mine Waste Materials

9.1.1 Geochemical assessment

The most reliable method to characterise the acid producing potential of a sample would be to undertake a range of analyses that include total sulfur (TS), sulfide sulfur (SS) measured using the chromium reducible sulfur method (CRS), sulfate (that can be measured in a range of fractions and species using various methods), the hydrogen ion concentration (pH), electrical conductivity (EC), total acid neutralising capacity (ANC_T), available ANC using the acid buffering characteristic curve (ABCC) method, mineralogy, and the single peroxide addition net acid generation (NAG) method (MEND, 2009). However, it is often cost prohibitive and unnecessary to undertake all these analyses on every sample.

RGS undertake pH, EC, TS, and ANC_T on all samples to screen them and undertake supplementary analyses on specific samples to understand anomalies or to verify assumptions. This approach results in a balance between sample coverage and cost and is an effective strategy for geochemical assessment.

9.1.2 Analytical program

The analytical program has three main objectives:

1. Quantify the total sulfur content and sulfate mobility of waste materials to evaluate the potential for sulfate drainage issues.
2. Quantify the sulfide content and potential neutralising capacity in all material types to verify the potential for the generation of AMD.
3. Assess the impacts of the mine waste materials on water quality over time using a series of analyses on leachates from kinetic leaching columns.

9.1.3 Analytical methods for AMD

To characterise the acid producing potential of a sample a range of analyses are generally undertaken including determination of total sulfur, sulfide sulfur measured using the chromium reducible sulfur method (CRS), sulfate (that can be measured in a range of fractions and species using various methods), the hydrogen ion concentration (pH), electrical conductivity (EC), acid neutralising capacity (ANC), available ANC using the acid buffering characteristic curve (ABCC) method, mineralogy, and the single peroxide addition net acid generation (NAG) method (MEND, 2009). However, it is often cost prohibitive and unnecessary to undertake all these analyses on every sample.

RGS undertakes pH, EC, TS, and ANC on all samples to screen them and undertake supplementary analyses on specific samples to understand anomalies or to verify assumptions. This approach results in a balance between sample coverage and cost and is an effective strategy for geochemical assessment.

9.1.4 Maximum potential acidity

Actual acidity

Actual acidity can be divided into soluble acidity and retained acidity. Soluble acidity is defined here as acidity measured using a 1:5 (soil:water) extract whereas retained acidity is defined as the acidity that is not recorded in such an extraction however, there is no clear-cut distinction between soluble acidity and retained acidity because part of the retained forms of acidity can be released during successive extractions with water. Soluble acidity can be subdivided into active soluble acidity and buffered acidity. Active soluble acidity accounts for the activity of hydrogen ions (H^+) whereas buffered soluble acidity accounts for other soluble acidic cations (mainly Fe^{2+}, $AlSO_4^+$ and Al^{3+}) that can produce hydrogen ions when they hydrolyse[2].

[2] Lin, C. Lancaster, L.A. Sullivan, D. McConchie, D. and Saenger, P. (2002). Actual Acidity in Acid Sulfate Soils: Chemical Processes and Analytical Methods. Acid Sulfate Soils in Australia and China.

Retained acidity can be sub-divided into (a) exchangeable acidity, (b) acidity carried by protonated variably charged particles, such as clays, and (c) acidity carried by basic sulfate minerals. These retained forms of acidity are temporarily immobilised by soils and are subject to re-mobilisation if geochemical conditions change, e.g. during liming, or re-flooding with brackish tidal water. Exchangeable acidity is acidity that is retained through cation exchange reactions[2]. An example of exchangeable acidity is found in the sulfate mineral Jarosite; One mole of jarosite carries three moles of acidity that can be released by hydrolysis:

$$KFe_3(OH)_6(SO_4)_2 + 3OH^- \dashrightarrow 3Fe(OH)_3 + 2SO_4^{2-} + K^+$$

Acidity that is buffered through protonation of variably charged particles can be released through their de-protonation, e.g.:

$$[Al(OH)]SO_4 + 2OH^- \dashrightarrow Al(OH)_3 + SO_4^{2-}$$

Potential acidity

Total sulfur is measured by combustion of the sample in a furnace at 1,350ºC in the presence of strong oxidants/catalysts. This method measures the total concentration of sulfur, including elemental sulfur, sulfur present in sulfide and sulfate minerals as well as organic sulfur. The most environmentally conservative approach to calculate maximum potential acidity (MPA) is to assume that all sulfur in a sample is sulfide and capable of generating acid. By convention in acid base accounting studies, it is assumed that the sulfide sulfur is present as pyrite (FeS_2). Therefore, the stoichiometry of pyrite oxidation is used to calculate a theoretical maximum amount of sulfuric acid that could be generated which is expressed in kg H_2SO_4 / tonne. However, this ignores the fact that not all sulfur will contribute to the generation of acidity (e.g. sulfate sulfur in gypsum and barite). As a result, the total sulfur concentration may overestimate the acid generation potential of a sample.

Sulfur can be present within acid producing primary minerals such as pyrite and marcasite (FeS_2), chalcopyrite ($CuFeS_2$) and bornite (Cu_5FeS_4) and non-acid producing primary minerals such as galena (PbS) and sphalerite (ZnS). Sulfur can also be also present as a large number of non-acid producing secondary minerals such as alunite ($KAl_3(SO_4)_2(OH)_6$), gypsum ($CaSO_4 \cdot 2H_2O$), through to minerals such as jarosite ($KFe^{3+}_3(OH)_6(SO4)_2$) that can store and release acid and trace, minor, and major elements.

To differentiate between total sulfur and sulfide sulfur the Chromium Reducible Sulfur (CRS) method was used to measure the sulfide sulfur. The CRS method provides a direct measure of reduced inorganic sulfur over the wide range of values encountered in acid sulfate soils and mineral waste in geological materials. The selectivity of the CRS test in samples containing residual organic sulfur makes it an ideal choice analytically to measure sulfide within primary sulfide minerals. While this method excludes sulfur present as sulfate, or organic sulfur, it does not differentiate between acid producing (e.g. pyrite) and non-acid producing (e.g. sphalerite) minerals.

Acid generation is caused by the exposure of sulfide minerals, most commonly pyrite (FeS_2), to atmospheric oxygen and water. Sulfur assay results are used to calculate the maximum acid that could be generated by the sample by either directly determining the pyritic sulfur content or assuming that all sulfur not present as sulfate occurs as pyrite. Pyrite reacts under oxidising conditions to generate acid according to the following overall reaction:

$$4FeS_2 + 15O_2 + 14H_2O \rightarrow 4Fe(OH)_3 + 8SO_4^{2-} + 16\ H^+$$

According to this reaction, the MPA of a sample containing 1% sulfur as pyrite would be 30.6 kg H_2SO_4/t. The chemical components of the acid generation process consist of the above sulfide oxidation reaction and acid neutralization, which is mainly provided by inherent carbonates and, to a lesser extent, silicate materials. The amount and rate of acid generation is determined by the interaction and overall balance of the acid generation and neutralisation components.

9.1.5 Acid neutralising capacity (ANC)

ANC can be measured by the peroxide siderite correction for the Sobek method that utilises digestion of a pulp sample with 0.5 M HCl, boiling and addition of 5mL of 30% H_2O_2. The sample is then back titrated with NaOH to measure the amount of acid consumed by reaction with the sample and provides the ANC_T in kg

H_2SO_4/t. Acid neutralising capacity is expressed in kg H_2SO_4/t of material representing the capacity of the solids to neutralise acid but not necessarily implying that calcite ($CaCO_3$) is present.

The primary minerals in geological materials that are readily able to neutralise acidity are calcium and magnesium carbonates. Secondary neutralising minerals accounted for in the measurement of total acid neutralising capacity include basic silicates such as calcic feldspars, olivine, amphiboles, and biotite. However, due to their slower dissolution rates, their contribution to the overall ANC is generally considered to be small under ambient conditions. Felsic silicates such as sodic and potassic feldspars, muscovite, most clay minerals, and quartz do not contribute significantly to the ANC. In addition, carbonate minerals that contain iron and/or manganese do not report to the ANC measurement. The relative reactivity of acid consuming minerals at pH 5 is provided in **Table 9-1**.

Table 9-1: Relative Mineral Reactivity

Mineral Group	Typical Minerals	Relative Reactivity at pH 5
Dissolving	Calcite, aragonite, dolomite, magnesite, brucite	1.0
Fast weathering	Anorthite, nepheline, olivine, jadeite, leucite, spodumene, diopside, wollastonite	0.6
Intermediate weathering	Epidote, zoisite, enstatite, hypersthene, augite, hedenbergite, hornblende, glaucophane, tremolite, actinolite, anthophyllite, serpentine, chrysotile, talc, chlorite, biotite	0.4
Slow weathering	Albite, oligoclase, labradorite, montmorillonite, vermiculite, gibbsite, kaolinite	0.02
Very slow weathering	K-feldspars, muscovite	0.01
Inert	Quartz, rutile, zircon	0.004

(Source http://technology.infomine.com/enviromine/ard/acid-base%20accounting/ABAdiscussion.htm)

9.1.6 Net acid producing potential and neutralisation potential ratio

Geochemical classification is achieved using the net acid producing potential (NAPP) of a sample, which is calculated from acid base accounting (ABA) procedures (COA, 2016). The NAPP value is derived as the difference between the maximum potential acidity (MPA) and total acid neutralising capacity (ANC_T) of a sample.

The ANC_T/MPA ratio (or Neutralising Potential Ratio (NPR)) is also used as a means of assessing the risk of acid generation from mine waste materials. The purpose of the ANC_T/MPA ratio is to provide an indication of the relative margin of safety within a material. As a general rule, an ANC_T/MPA ratio of 2 or more signifies that there is a high probability that the material will remain circum-neutral in pH (AMIRA, 2002; INAP, 2009).

9.1.7 Metalliferous drainage potential

The potential of a geological material to leach trace, minor, or major elements (salts, metals, and metalloids) is a function of the fractionation and speciation of the elements and the way the mine waste materials will be managed. The static methods used in this assessment have measured the “whole rock” and “water soluble” fractions of these elements.

The geochemical abundance index (GAI) quantifies a “whole rock” assay result for a particular element in terms of the average crustal abundance for that element. The index, based on a log (2) scale, is expressed in seven integer increments (0 to 6), which correspond to enrichment factors from 0 to over 96 times average crustal abundance, as shown in **Table 9-2.**.

Table 9-2. Geochemical Abundance Index (GAI) values and Enrichment Factor

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

As a rule, a GAI greater than or equal to three indicates element enrichment to a level that may warrant further investigation (INAP, 2009). This is the case with some environmentally important 'trace' elements, such as As, Cd, Cu, and Zn, rather than with major rock-forming elements, such as Ca, Mg, K, and Na. Elements identified as enriched may not necessarily be a concern for revegetation, drainage water quality, or public health, but their significance should still be evaluated. Similarly, because an element is not enriched does not mean it will never be a concern, because under some conditions (e.g. low pH) the solubility of common environmentally important elements such as Al, Cu, Cd, Fe, and Zn increases significantly.

A static water leach method can be used to measure the water-soluble pH, EC, and the concentration of major ions and trace metals/metalloids in water extracts.

The water leach test results are effected by the particle size distribution used in the analysis, the water to sample ratio used (1:1, 1:2 (paste), 1:3, or 1:5 are common ratios used, although some methods use 1:20 rations e.g. TCLP) It should be recognised that direct comparison of static water leach tests with guideline values can be misleading. RGS has a preference to evaluate the solubility of metals and major ions from mine waste using kinetic leach cell testing that provides the rate of weathering and associated concentration of elements in the leachate.

9.1.8 Saline drainage potential

Saline drainage is of concern to regulators in Queensland and other states and territories. Saline drainage can come from the release of major cations and anions from geological units due to weathering of the host rock, or from the accumulation of elements over time e.g. accumulation of NaCl in soil from rain.

Saline drainage can also be attributed to sulfide oxidation process that release sulfate and or the weathering of sulfate minerals such as gypsum. Sulfate and other major ions such as NaCl can be present under both acid and neutral pH conditions.

Soil characterisation

Cation Exchange Capacity (CEC) is the soils capacity to hold and exchange cations; CEC provides a buffer to changes in pH, available nutrients, calcium levels, and soil stability (Hazelton and Murphy, 2007).

Exchangeable Sodium Percentage (ESP) is used in the classification of saline and alkali soils or to determine if a sodium hazard exists. Generally, samples with ESP values less than 6 % are considered non-sodic, and greater than 14 % are considered strongly sodic and may be susceptible to dispersion and erosion (Isbell, 2016; and Northcote and Skene, 1972).

Rengasamy et. al. (1984) derived relationships between sodium adsorption ratio (SAR) and total cation concentration (TCC) (and by calculation ESP and EC) values to classify soils into Class 1, Class 2A, Class 2B (dispersive soils) and Class 3A and Class 3B (flocculated soils) (**Table 9-3**).

CEC and ESP are derived from soil fertility analyses.

Table 9-3. Description of soil dispersion classification (Rengasamy et al, 1984)

Equation*	Horizon	Soil classes
Class 1: Dispersive Soil		
TCC < 0.16 SAR + 0.14	-	Dispersive soils that disperse spontaneously in water. These are unstable, sodic soils that can have severe management and erosion problems
Class 2: Potentially Dispersive Soils		

Potentially dispersive soils that disperse after the application of mechanical work either by raindrop impact, irrigation, or tillage. This was simulated by one hour of end to end shaking in the laboratory.		
TCC < 1.21 SAR + 3.3	SAR < 3	**Class 2A:** Soils that have few structural problems if managed using minimum tillage techniques or if maintained under continuous pasture growth
TCC < 1.21 SAR + 3.3	SAR > 3	**Class 2B:** Unlike Class 2a soils, these soils become spontaneously dispersive (Class 1) when leached without the addition of calcium compounds, and if there is no generation of electrolytes in the soil due to mineral weathering
TCC < 1.21 SAR + 3.3	SAR > 3	**Class 2C:** *(not shown)* Subsoil (B-horizon) that require higher electrolyte levels (3.19 SAR -1.7) m.e. L^{-1} to prevent dispersion. Potential severe surface structure problems than corresponding areas where the topsoil is retained.
Class 3: Flocculated Soils		
Flocculated soils that remain flocculated even when subjected to mechanical stress. Typical flocculation value of 7 m.e. L^{-1} or more (saturation extract EC of approximately 4 dS m^{-1})		
TCC > 1.21 SAR + 3.3	SAR >3	**Class 3A:** Leaching with low electrolyte water may change saline-sodic soil to Class 2b, or in extreme leaching to Class 1. Soils may then disperse and cause severe crusting
TCC > 1.21 SAR + 3.3	SAR<3, TCC>7	**Class 3B:** These soils are saline but dominated by non-sodium salts. These soils have no physical problems and the amount of leaching required depends on the salt tolerance of crops to be grown.
TCC > 1.21 SAR + 3.3	SAR<3, TCC<7	**Class 3C:** No dispersion and salinity problems occur where total cation concentration (TCC) is greater than 20

Assumptions: ESP and EC are linearly correlated to SAR and TCC, based on Original Plot by Rengasamy et al (1984) and Modified Plot by Marchuk (2013) and adhere to conditions listed in Hazelton et al (2007) below:

(1) The correlation between ESP and Sodium Absorption Ratio (SAR) depends on whether SAR is calculated from cation concentrations determined from saturated paste extracts or from 1: 5 soil/water suspensions. Cation concentrations based on paste extracts measurements has the approximate correlation of ESP ~ SAR, and a soil is sodic if SAR (1:5) > 5-6. Cation concentration based on 1:5 soil/water suspensions uses ESP ~ 2 x SAR approximate correlation, which means soil is sodic if SAR (1:5) > 2.5-3. ESP is based on 1:5 soil/water suspension.

(2) The relationship between Total Cation Concentration (TCC) (mmol/L) and Electrical Conductivity (EC) (dS/cm) is linear for solutions with EC < 10 dS/cm and can be expressed as TCC ~ 10 x EC. The EC for samples handled by RGS is below 10 dS/cm (100000 µS/cm). EC is based on 1:5 soil/water suspension.

Emerson Aggregate class testing

The Emerson Class test (ECT) is a physical analytical method used to qualify if a clay or soil ped will disperse or flocculate in solution. The ECT can be used as a general guide to sodicity. The aggregate test can be used only as a general guide because of the large number of factors that determine whether dispersion occurs such as sodicity, salinity, clay type, history of working, and speed of wetting (Hazelton and Murphy, 2007).

Dispersion describes the behaviour of clay particles separating from one other in a moist soil: dispersion can cause soil aggregates to breakdown and the dispersed clay to clog soil pores: structural decline and erosion usually result (Baxter and Williamson, 2001).

Flocculated soils are favourable soils for rehabilitation because they contain particles which, when dispersed in a solution, remain in contact and adhere to each other forming clumps of a larger size (Baxter and Williamson, 2001). The flocculated clays tend to be stable hence result in a resilient soil structure. Flocculated clays encourage soils to aggregate, and soils with stable aggregates allow water infiltration and drainage, provide pore spaces for air and water storage, enhance soil flora and fauna, and are more resistant to erosion.

9.1.9 Multi-element testing

Total metals and metalloids

Total (whole rock) metal(loid) analysis (ME-MS41) involves a 2 acid-digestion using a 1:1 ratio of hydrochloric acid (HCl) and nitric acid (HNO_3), followed by trace element analysis by ICP-MS. This digestion does not dissolve the silicate matrix or other extremely resilient minerals, such as zircon.

Soluble metals and metalloids

Soluble metal(loid) (shake flask extractions) are tested on leached samples at a 1:3 w:v ratio for 16 hours. Leaching is not required if the sample is already in an aqueous form.

9.1.10 Physical testing

Particle size distribution

Particle size distribution (PSD) tests determines the size and range of particles representative of a sample. Techniques include coarse PSD (150 to 0.075 mm) and fine PSD with hydrometer (0.075 to 0.0014 mm).

Permeability

Permeability (k) measures the flow of water through a substrate. Permeability is measured with constant head or falling head at 80% – 95% density. In the constant head method, the top of the water column (head pressure) remains above the sample throughout the test and is commonly used for soils with a high flow rate, such as sands and gravels. In the falling head method, the head decreases as water infiltrates the sample, gradually decreasing pressure over the course of the test. This method is more suitable for fine grained soils. Permeability ($k_{(20)}$) is expressed in m/s.

Soil-water characteristic curves

The soil-water characteristic curve (SWCC), also known as a retention curve, shows the relationship between matric suction and water content. It is used to determine the hydraulic and mechanical behaviour of unsaturated soils and to help predict water storage. SWCC are also used in geotechnical engineering to evaluate and predict the failure of slopes during heavy rainfall events. Matric suction refers to the height at which water can be drawn up (i.e capillary rise) into an unsaturated soil. SWCC are typically sigmoidal in shape and include a sharp transition zone that precedes residual conditions.

Point load strength

Point load testing is an index which measures the strength characteristics of intact rocks. After determining sample dimensions, the sample is loaded with uniformly increasing force so that a break occurs between 10 – 60 seconds. The strength index (Is) is usually carried out on core samples of 50 mm diameter for which no correction is required (Is(50)). However, if the sample has different dimensions, it is termed an ‘irregular lump’ and must be corrected. The application of such a correction factor introduces possible inaccuracy (Broch and Franklin, 1972).

9.2 Attachment B: Summary results – static data

9.2.1 Table B1: Acid Base Account test results

Table B1: Acid Base Account (ABA) analysis results for Broadmeadow East

RGS Sample No.	Drill Hole ID	Sample Lithology	pH[1]	EC[1] (µS/cm)	Total S (%)	CRS (%)	% Different	Scr[2] (%)	MPA[2] (TS) (kg H_2SO_4/t)	MPA2 (CRS) (kg H_2SO_4/t)	ANC[2] (kg H_2SO_4/t)	NAPP[2] (kg H_2SO_4/t)	NAPP[3]	ANC: MPA Ratio (TS)	ANC:MPA Ratio (CRS)	Sample Classification[3]
Coal Quality																
2020057_3001	CQBE0001	Roof	9.3	486	0.19	0.13	71	0.13	5.8	4.1	19.2	-13.4	-15.1	3.3	4.7	Non-Acid Forming (Barren)
2020057_3002	CQBE0001	Roof	8.9	418	0.37	0.24	65	0.24	11.3	7.4	75.4	-64.1	-68.1	6.7	10.3	Non-Acid Forming (NAF)
2020057_3003	CQBE0001	Immediate Roof	9.1	606	0.2	0.17	85	0.17	6.1	5.2	38.3	-32.2	-33.1	6.3	7.4	Non-Acid Forming (Barren)
2020057_3004	CQBE0001	Coal	8.4	395	0.26	0.09	35	0.09	8.0	2.8	32.6	-24.6	-29.8	4.1	11.6	Non-Acid Forming (Barren)
2020057_3005	CQBE0001	Coal	8.3	357	0.4	0.13	31	0.13	12.3	3.8	11.8	0.4	-8.0	1.0	3.1	Non-Acid Forming (Barren)
2020057_3006	CQBE0002	Roof	9	414	0.07	0.05	67	0.05	2.1	1.4	266	-263.9	-264.6	124.1	184.8	Acid Consuming
2020057_3008	CQBE0002	Roof	9	440	0.28	0.18	65	0.18	8.6	5.6	18.8	-10.2	-13.2	2.2	3.4	Non-Acid Forming (Barren)
2020057_3009	CQBE0002	Immediate Roof	9	486	0.19	0.08	39	0.08	5.8	2.3	28.3	-22.5	-26.0	4.9	12.3	Non-Acid Forming (Barren)
2020057_3010	CQBE0002	Coal	8.7	218	0.29	0.06	20	0.06	8.9	1.8	35.7	-26.8	-33.9	4.0	20.1	Non-Acid Forming (Barren)
2020057_3011	CQBE0002	Coal	8.6	308	0.39	0.10	26	0.10	11.9	3.1	17.4	-5.5	-14.3	1.5	5.6	Non-Acid Forming (Barren)
2020057_3012	CQBE0002	Floor	9.1	433	0.12	0.03	28	0.03	3.7	1.0	8.4	-4.7	-7.4	2.3	8.1	Non-Acid Forming (Barren)
2020057_3013	CQBE0003	Roof	9.3	333	0.03	0.03	83	0.03	0.9	0.8	91.1	-90.2	-90.3	99.2	119.0	Non-Acid Forming (Barren)
2020057_3014	CQBE0003	Roof	9.2	307	0.12	0.04	33	0.04	3.7	1.2	76.6	-72.9	-75.4	20.8	62.5	Non-Acid Forming (Barren)
2020057_3015	CQBE0003	Roof	9	348	0.25	0.19	74	0.19	7.7	5.7	28.4	-20.7	-22.7	3.7	5.0	Non-Acid Forming (Barren)
2020057_3016	CQBE0003	Immediate Roof/Roof	8.9	395	0.28	0.18	63	0.18	8.6	5.4	167	-158.4	-161.6	19.5	31.0	Acid Consuming
2020057_3017	CQBE0003	Coal	8.1	368	0.47	0.25	53	0.25	14.4	7.6	30.1	-15.7	-22.5	2.1	4.0	Non-Acid Forming (NAF)
2020057_3018	CQBE0003	Coal	7.4	1010	2.05	1.60	78	1.60	62.8	49.0	23.6	39.2	25.4	0.4	0.5	PAF (High Risk)
2020057_3019	CQBE0003	Coal	7.9	698	2.3	1.68	73	1.68	70.4	51.5	53.9	16.5	-2.5	0.8	1.0	PAF (High Risk)
2020057_3020	CQBE0003	Coal	8.9	811	0.87	0.75	86	0.75	26.6	22.8	109	-82.4	-86.2	4.1	4.8	PAF
2020057_3021	CQBE0003	Coal	8.9	561	1.08	0.89	83	0.89	33.1	27.3	112	-78.9	-84.7	3.4	4.1	PAF
2020057_3022	CQBE0003	Floor	9.4	256	0.04	0.03	78	0.03	1.2	0.9	13.4	-12.2	-12.5	10.9	14.1	Non-Acid Forming (Barren)
2020057_3023	CQBE0004	Coal	8.8	137	0.28	0.02	5	0.02	8.6	0.5	28.6	-20.0	-28.1	3.3	62.3	Non-Acid Forming (Barren)
2020057_3024	CQBE0004	Coal	8.2	78	0.3	0.01	5	0.01	9.2	0.4	2.7	6.5	-2.3	0.3	6.3	Non-Acid Forming (Barren)
2020057_3025	CQBE0004	Floor	9.1	192	0.04	0.02	43	0.02	1.2	0.5	9.5	-8.3	-9.0	7.8	18.2	Non-Acid Forming (Barren)
2020057_3026	CQBE0006	Coal	6.6	478	0.96	0.59	61	0.59	29.4	18.0	7.4	22.0	10.6	0.3	0.4	PAF
2020057_3027	CQBE0006	Coal	7.9	336	0.8	0.46	57	0.46	24.5	14.0	6.7	17.8	7.3	0.3	0.5	Acid Consuming
2020057_3028	CQBE0006	Floor	8.1	236	0.27	0.19	70	0.19	8.3	5.8	19.7	-11.4	-13.9	2.4	3.4	Non-Acid Forming (Barren)
2020057_3029	CQBE0008	Coal	7.7	486	0.82	0.45	55	0.45	25.1	13.8	20.9	4.2	-7.1	0.8	1.5	Potentially Acid Forming (PAF) (Low Capacity)
2020057_3030	CQBE0008	Coal	7.8	349	0.76	0.39	52	0.39	23.3	12.0	11.2	12.1	0.8	0.5	0.9	Acid Consuming
2020057_3031	CQBE0008	Floor	8.6	176	0.21	0.17	81	0.17	6.4	5.2	14.2	-7.8	-9.0	2.2	2.7	Non-Acid Forming (Barren)
2020057_3032	All Holes	Roof	8.4	383	0.33	0.24	72	0.24	10.1	7.3	150	-139.9	-142.7	14.8	20.7	Acid Consuming
2020057_3033	All Holes	Floor	9	429	0.23	0.16	67	0.16	7.0	4.7	10	-3.0	-5.3	1.4	2.1	Non-Acid Forming (Barren)
Drill Hole																
2020057_C1001	CQBE0001	Soil	8.4	453	0.01	0.01	70	0.01	0.3	0.2	16.4	-16.1	-16.2	53.6	76.5	Non-Acid Forming (Barren)
2020057_C1002	CQBE0001	Clay	9.2	572	0.005	0.01	140	0.01	0.2	0.2	50.8	-50.8	-50.6	331.8	237.0	Non-Acid Forming (Barren)
2020057_C1003	CQBE0001	Clay	8.9	762	0.005	0.01	140	0.01	0.2	0.2	51.3	-51.3	-51.1	335.0	239.3	Non-Acid Forming (Barren)
2020057_C1004	CQBE0001	Clay	8.9	727	0.005	0.01	140	0.01	0.2	0.2	57.5	-57.5	-57.3	375.5	268.2	Non-Acid Forming (Barren)
2020057_C1005	CQBE0001	Siltstone	9	601	0.005	0.01	140	0.01	0.2	0.2	90.2	-90.2	-90.0	589.1	420.8	Non-Acid Forming (Barren)
2020057_C1006	CQBE0001	Siltstone	8.9	565	0.03	0.01	43	0.01	0.9	0.4	41	-40.1	-40.6	44.6	103.0	Non-Acid Forming (Barren)
2020057_C1007	CQBE0001	Sandstone	9	404	0.02	0.02	100	0.02	0.6	0.6	152	-151	-151.4	248.2	248.2	Acid Consuming
2020057_C1008	CQBE0001	Siltstone/Sandstone	9.2	419	0.04	0.02	50	0.02	1.2	0.6	18.9	-17.7	-18.3	15.4	30.9	Non-Acid Forming (Barren)
2020057_C1009	CQBE0002	Soil	7.6	303	0.005	0.01	180	0.01	0.2	0.3	9.3	-9.3	-9.0	60.7	33.7	Non-Acid Forming (Barren)
2020057_C1010	CQBE0002	Soil	7.9	466	0.01	0.01	90	0.01	0.3	0.3	14.9	-14.6	-14.6	48.7	54.1	Non-Acid Forming (Barren)
2020057_C1011	CQBE0002	Clay	8.5	561	0.01	0.01	90	0.01	0.3	0.3	17.7	-17.4	-17.4	57.8	64.2	Non-Acid Forming (Barren)
2020057_C1012	CQBE0002	Siltstone	8.9	591	0.01	0.01	90	0.01	0.3	0.3	82.3	-82	-82.0	268.7	298.6	Non-Acid Forming (Barren)
2020057_C1013	CQBE0002	Siltstone	8.7	718	0.005	0.01	180	0.01	0.2	0.3	65.9	-65.9	-65.6	430.4	239.1	Non-Acid Forming (Barren)
2020057_C1014	CQBE0002	Siltstone	8.8	727	0.005	0.01	200	0.01	0.2	0.3	35.7	-35.7	-35.4	233.1	116.6	Non-Acid Forming (Barren)
2020057_C1015	CQBE0002	Sandstone	8.6	612	0.005	0.01	200	0.01	0.2	0.3	91.7	-91.7	-91.4	598.9	299.4	Non-Acid Forming (Barren)
2020057_C1016	CQBE0002	Siltstone	8.6	509	0.005	0.01	200	0.01	0.2	0.3	40.5	-40.5	-40.2	264.5	132.2	Non-Acid Forming (Barren)
2020057_C1017	CQBE0002	Claystone	8.8	456	0.005	0.01	260	0.01	0.2	0.4	254	-254	-253.6	1658.8	638.0	Acid Consuming
2020057_C1018	CQBE0002	Siltstone	8.8	622	0.02	0.01	65	0.01	0.6	0.4	37	-36.4	-36.6	60.4	92.9	Non-Acid Forming (Barren)
2020057_C1019	CQBE0002	Carbonaceous Sandstone	8.7	566	0.05	0.01	20	0.01	1.5	0.3	32.8	-31.3	-32.5	21.4	107.1	Non-Acid Forming (Barren)
2020057_C1020	CQBE0002	Carbonaceous Sandstone/Siltstone	8.4	553	0.35	0.13	37	0.13	10.7	4.0	23	-12.3	-19.0	2.1	5.8	Non-Acid Forming (Barren)
2020057_C1021	CQBE0002	Siltstone	8.8	513	0.05	0.13	258	0.13	1.5	4.0	15.8	-14.3	-11.8	10.3	4.0	Non-Acid Forming (Barren)
2020057_C1022	CQBE0003	Soil	7.1	272	0.01	0.0025	25	0.0025	0.3	0.1	12.1	-11.8	-12.0	39.5	158.0	Non-Acid Forming (Barren)
2020057_C1023	CQBE0003	Siltstone	8.3	274	0.005	0.0025	50	0.0025	0.2	0.1	70	-70	-69.9	457.1	914.3	Non-Acid Forming (Barren)

Table B1: Acid Base Account (ABA) analysis results for Broadmeadow East

RGS Sample No.	Drill Hole ID	Sample Lithology	pH[1]	EC[1]	Total S	CRS	% Different	Scr[2]	MPA[2] (TS)	MPA2 (CRS)	ANC[2]	NAPP[2]	NAPP[3]	ANC: MPA Ratio (TS)	ANC:MPA Ratio (CRS)	Sample Classification[3]
				(µS/cm)	(%)	(%)		(%)	(kg H_2SO_4/t)							
2020057_C1024	CQBE0003	Siltstone	8.4	243	0.005	0.0025	50	0.0025	0.2	0.1	110	-110	-109.9	718.4	1436.7	Acid Consuming
2020057_C1025	CQBE0003	Siltstone	8.4	328	0.005	0.0025	50	0.0025	0.2	0.1	73.4	-73.4	-73.3	479.3	958.7	Non-Acid Forming (Barren)
2020057_C1026	CQBE0003	Siltstone	8.4	413	0.005	0.0025	50	0.0025	0.2	0.1	117	-117	-116.9	764.1	1528.2	Acid Consuming
2020057_C1027	CQBE0003	Siltstone	8.4	514	0.005	0.02	340	0.02	0.2	0.5	57.2	-57.2	-56.7	373.6	109.9	Non-Acid Forming (Barren)
2020057_C1028	CQBE0003	Siltstone	8.6	376	0.02	0.02	85	0.02	0.6	0.5	32.2	-31.6	-31.7	52.6	61.8	Non-Acid Forming (Barren)
2020057_C1029	CQBE0003	Carbonaceous Siltstone/Siltstone	8.6	379	0.12	0.07	58	0.07	3.7	2.1	28.8	-25.1	-26.7	7.8	13.6	Non-Acid Forming (Barren)
2020057_C1030	CQBE0003	Siltstone	8.4	535	0.13	0.07	53	0.07	4.0	2.1	38.7	-34.7	-36.6	9.7	18.3	Non-Acid Forming (Barren)
2020057_C1031	CQBE0004	Soil	7.4	284	0.01	0.01	100	0.01	0.3	0.3	5.8	-5.5	-5.5	18.9	18.9	Non-Acid Forming (Barren)
2020057_C1032	CQBE0004	Silt	8	340	0.01	0.01	100	0.01	0.3	0.3	7.6	-7.3	-7.3	24.8	24.8	Non-Acid Forming (Barren)
2020057_C1033	CQBE0004	Siltstone	8.5	638	0.02	0.01	50	0.01	0.6	0.3	31.2	-30.6	-30.9	50.9	101.9	Non-Acid Forming (Barren)
2020057_C1034	CQBE0004	Siltstone	8.2	589	0.01	0.01	100	0.01	0.3	0.3	8.1	-7.8	-7.8	26.4	26.4	Non-Acid Forming (Barren)
2020057_C1035	CQBE0004	Siltstone	7.9	730	0.02	0.01	50	0.01	0.6	0.3	6.6	-6	-6.3	10.8	21.6	Non-Acid Forming (Barren)
2020057_C1036	CQBE0004	Siltstone	8.7	682	0.02	0.02	75	0.02	0.6	0.5	29.2	-28.6	-28.7	47.7	63.6	Non-Acid Forming (Barren)
2020057_C1037	CQBE0004	Siltstone/Sandstone	8.7	690	0.08	0.08	98	0.08	2.5	2.4	34	-31.6	-31.6	13.9	14.2	Non-Acid Forming (Barren)
2020057_C1038	CQBE0004	Sandstone	8.9	536	0.01	0.08	780	0.08	0.3	2.4	65.9	-65.6	-63.5	215.2	27.6	Non-Acid Forming (Barren)
2020057_C1039	CQBE0004	Siltstone	9	408	0.02	0.01	55	0.01	0.6	0.3	43	-42.4	-42.7	70.2	127.6	Non-Acid Forming (Barren)
2020057_C1040	CQBE0004	Carbonaceous Siltstone/Siltstone	8.8	390	0.03	0.02	80	0.02	0.9	0.7	27.5	-26.6	-26.8	29.9	37.4	Non-Acid Forming (Barren)
2020057_C1041	CQBE0004	Coal/Carbonaceous Mudstone/Carbonaceous Siltstone/Siltstone	8.7	387	0.1	0.02	24	0.02	3.1	0.7	16.3	-13.2	-15.6	5.3	22.2	Non-Acid Forming (Barren)
2020057_C1042	CQBE0004	Siltstone	8.6	311	0.08	0.02	30	0.02	2.5	0.7	13.8	-11.4	-13.1	5.6	18.8	Non-Acid Forming (Barren)
2020057_C1043	RSBE0005	Soil	7.5	231	0.02	0.01	45	0.01	0.6	0.3	4.8	-4.2	-4.5	7.8	17.4	Non-Acid Forming (Barren)
2020057_C1044	RSBE0005	Siltstone	8.3	426	0.01	0.01	90	0.01	0.3	0.3	16.9	-16.6	-16.6	55.2	61.3	Non-Acid Forming (Barren)
2020057_C1045	RSBE0005	Siltstone	8.1	197	0.03	0.01	30	0.01	0.9	0.3	4.6	-3.7	-4.3	5.0	16.7	Non-Acid Forming (Barren)
2020057_C1046	RSBE0005	Siltstone	8	358	0.01	0.01	90	0.01	0.3	0.3	6.1	-5.8	-5.8	19.9	22.1	Non-Acid Forming (Barren)
2020057_C1047	RSBE0005	Siltstone	8.2	392	0.01	0.01	90	0.01	0.3	0.3	6	-5.7	-5.7	19.6	21.8	Non-Acid Forming (Barren)
2020057_C1048	RSBE0005	Siltstone	8.5	538	0.005	0.01	180	0.01	0.2	0.3	22.1	-22.1	-21.8	144.3	80.2	Non-Acid Forming (Barren)
2020057_C1049	RSBE0005	Sandstone	8.6	334	0.005	0.01	180	0.01	0.2	0.3	61.1	-61.1	-60.8	399.0	221.7	Non-Acid Forming (Barren)
2020057_C1050	RSBE0005	Siltstone	8.7	335	0.04	0.01	33	0.01	1.2	0.4	71.5	-70.3	-71.1	58.4	179.6	Non-Acid Forming (Barren)
2020057_C1051	RSBE0005	Sandstone	8.8	357	0.03	0.01	43	0.01	0.9	0.4	34.7	-33.8	-34.3	37.8	87.2	Non-Acid Forming (Barren)
2020057_C1052	RSBE0005	Siltstone	8.8	369	0.03	0.01	43	0.01	0.9	0.4	46.7	-45.8	-46.3	50.8	117.3	Non-Acid Forming (Barren)
2020057_C1053	RSBE0005	Sandstone	9	362	0.02	0.01	65	0.01	0.6	0.4	58	-57.4	-57.6	94.7	145.7	Non-Acid Forming (Barren)
2020057_C1054	RSBE0005	Siltstone	8.5	330	0.02	0.03	125	0.03	0.6	0.8	61	-60.4	-60.2	99.6	79.7	Non-Acid Forming (Barren)
2020057_C1055	RSBE0005	Carbonaceous Siltstone	8.4	375	0.16	0.12	76	0.12	4.9	3.7	22.2	-17.3	-18.5	4.5	6.0	Non-Acid Forming (Barren)
2020057_C1056	RSBE0005	Carbonaceous Siltstone	8.4	437	0.12	0.12	101	0.12	3.7	3.7	21	-17.3	-17.3	5.7	5.7	Non-Acid Forming (Barren)
2020057_C1057	RSBE0005	Coal	6.9	1210	1.52	0.70	46	0.70	46.6	21.4	19	27.5	2.4	0.4	0.9	PAF
2020057_C1058	RSBE0005	Coal	7.8	817	0.55	0.39	71	0.39	16.8	12.0	16.2	0.6	-4.2	1.0	1.3	Potentially Acid Forming (PAF) (Low Capacity)
2020057_C1059	CQBE0006	Coal/Siltstone	8.5	363	0.17	0.10	61	0.10	5.2	3.2	17.8	-12.6	-14.6	3.4	5.6	Non-Acid Forming (Barren)
2020057_C1060	CQBE0006	Carbonaceous Mudstone/Siltstone	8.1	569	0.49	0.30	61	0.30	15.0	9.1	22.9	-7.9	-13.8	1.5	2.5	NAF (Low Capacity)
2020057_C1061	RSBE0007	Soil	6.4	98	0.02	0.01	50	0.01	0.6	0.3	2.8	-2.2	-2.5	4.6	9.1	Non-Acid Forming (Barren)
2020057_C1062	RSBE0007	Siltstone	5.9	73	0.03	0.01	33	0.01	0.9	0.3	1.9	-1	-1.6	2.1	6.2	Non-Acid Forming (Barren)
2020057_C1063	RSBE0007	Siltstone	6	72	0.01	0.01	100	0.01	0.3	0.3	1.5	-1.2	-1.2	4.9	4.9	Non-Acid Forming (Barren)
2020057_C1064	RSBE0007	Siltstone	5.8	124	0.02	0.01	50	0.01	0.6	0.3	1.5	-0.9	-1.2	2.4	4.9	Non-Acid Forming (Barren)
2020057_C1065	RSBE0007	Siltstone	5.9	81	0.01	0.01	100	0.01	0.3	0.3	1.5	-1.2	-1.2	4.9	4.9	Non-Acid Forming (Barren)
2020057_C1066	RSBE0007	Siltstone	6	172	0.02	0.01	65	0.01	0.6	0.4	3.2	-2.6	-2.8	5.2	8.0	Non-Acid Forming (Barren)
2020057_C1067	RSBE0007	Siltstone	8	336	0.02	0.01	65	0.01	0.6	0.4	31.9	-31.3	-31.5	52.1	80.1	Non-Acid Forming (Barren)
2020057_C1068	RSBE0007	Siltstone	8.3	234	0.03	0.02	67	0.02	0.9	0.6	46	-45.1	-45.4	50.1	75.1	Non-Acid Forming (Barren)
2020057_C1069	RSBE0007	Carbonaceous Siltstone	8.3	329	0.08	0.03	41	0.03	2.5	1.0	37.8	-35.4	-36.8	15.4	37.4	Non-Acid Forming (Barren)
2020057_C1070	RSBE0007	Siltstone	8.5	294	0.03	0.03	110	0.03	0.9	1.0	56.7	-55.8	-55.7	61.7	56.1	Non-Acid Forming (Barren)
2020057_C1071	RSBE0007	Carbonaceous Siltstone	8.3	342	0.12	0.10	83	0.10	3.7	3.1	23.3	-19.6	-20.2	6.3	7.6	Non-Acid Forming (Barren)
2020057_C1072	RSBE0007	Carbonaceous Siltstone	7.8	532	0.34	0.19	54	0.19	10.4	5.7	16.4	-6	-10.7	1.6	2.9	Non-Acid Forming (Barren)
2020057_C1073	RSBE0007	Coal	7.7	1100	1.75	1.34	77	1.34	53.6	41.0	37	16.6	4.0	0.7	0.9	PAF (High Risk)

1. pH, EC, Alkalinity and Acidity provided for 1:5 sample:water extracts
2. MPA = Maximum Potential Acidity; ANC = Acid Neutralising Capacity; and NAPP = Net Acid Producing Potential.
3. Sample classification criteria detail provided in report text.
* Where total sulfur or ANC results are less than the laboratory LoR a value of half of the LoR is used in Table B1.

9.2.2 Table B2: Multi-element test results

Table B2: Whole rock multi-element analysis results for Broadmeadow East

RGS Sample Number →		2020057_C1103	2020057_C1104	2020057_C1105	2020057_C1106	2020057_C1107	2020057_C1108	2020057_C1109	2020057_C1110	2020057_C1111	2020057_C1112	2020057_C1113	2020057_C1114
Sampling Date →		3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021
ALS Laboratory ID →		EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627
Parameters	Limit of Reporting	**TOPSOIL**	**SLT**	**SS/SLT**	**TOPSOIL**	**SLT/SS**	**SLT**	**XSS**	**XSS/SLT**	**TOPSOIL**	**SLT**	**XLST/SLT**	**TOPSOIL/SLT**
Major Cations		All units mg/kg											
Calcium (Ca)	50	18400	15600	35300	13400	18900	14600	8700	4200	23100	13900	7000	4300
Magnesium (Mg)	50	5600	5200	5500	2800	5900	5200	4500	4000	4700	4800	5700	2500
Potassium (K)	50	1400	1200	1500	1500	1400	1400	1200	2200	1400	1400	2000	900
Sodium (Na)	50	1600	1200	1000	900	1200	1100	1200	1300	400	700	800	1300
Major, Minor and Trace Elements		All units mg/kg											
Aluminium (Al)	50	14100	12500	9900	17000	17100	14000	14700	12300	19200	14100	14300	12700
Antimony (Sb)	0.1	0.17	0.28	0.23	0.46	0.47	0.26	0.47	0.89	0.23	0.28	0.79	0.36
Arsenic (As)	0.1	3.4	6.8	10.8	7.8	17.2	7.4	21.7	13.6	7.1	10.1	22.9	7.1
Barium (Ba)	0.1	170	110	160	160	50	40	290	350	110	130	100	220
Beryllium (Be)	0.1	0.87	1.22	1.14	0.83	0.91	1.06	1.13	1.07	0.82	1.17	1.23	0.86
Bismuth (Bi)	0.1	0.19	0.28	0.22	0.14	0.19	0.41	0.43	0.4	0.15	0.38	0.37	0.12
Boron (B)	50	10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	10
Cadmium (Cd)	0.1	0.07	0.11	0.09	0.02	0.05	0.15	0.12	0.12	0.07	0.11	0.1	0.02
Caesium (Cs)	0.05	1.47	1.56	2.07	1.65	1.82	2.05	1.98	4.91	1.46	2.12	5.58	1.38
Cerium (Ce)	0.01	16.1	15.8	19.35	15.2	9.94	17.05	21.7	9.02	15	15	14.75	20.7
Chromium (Cr)	0.1	19	15	12	34	20	15	16	10	25	15	11	64
Cobalt (Co)	0.1	13.7	15.6	12.9	10.2	16.6	14.9	13.9	7.6	16.7	16.6	13.2	18.3
Copper (Cu)	0.1	23.9	34.5	32.5	18.9	29.1	53.2	52	49.5	19.7	48.4	45.5	18.8
Gallium (Ga)	0.05	4.57	4.98	3.65	6.3	6.48	5.15	6.62	3.79	7.09	6.1	4.62	5.56
Germanium (Ge)	0.05	0.06	0.07	0.06	0.05	0.06	0.07	0.07	<0.05	0.05	0.06	0.05	0.06
Gold (Au)	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Hafnium (Hf)	0.1	0.14	0.18	0.15	0.12	0.14	0.17	0.2	0.13	0.11	0.17	0.14	0.15
Indium (In)	0.005	0.033	0.05	0.047	0.03	0.036	0.055	0.08	0.052	0.034	0.054	0.06	0.033
Iron (Fe)	50	31500	45000	43300	32000	39000	30400	31200	20400	35400	37400	56000	49400
Lanthanum (La)	0.5	6.3	6	7.1	6.4	3.8	6.9	8.7	3.5	5.8	5.8	5.2	6.8
Lead (Pb)	0.1	12.6	19.1	17.2	10.1	15.5	25.6	25.3	19.1	12.5	20.7	20.4	12.7
Lithium (Li)	0.1	7.4	9.2	7.7	7.3	12.7	9.3	11.8	10.3	9.5	10.1	13.9	5.1
Manganese (Mn)	0.1	609	671	944	441	692	665	656	298	881	717	1200	586
Mercury (Hg)	0.005	0.01	0.01	0.05	0.01	0.01	0.02	0.05	0.12	0.01	0.02	0.11	0.01
Molybdenum (Mo)	0.1	0.13	0.38	0.5	0.3	0.43	0.33	0.83	1.31	0.15	0.45	1.04	0.37
Nickel (Ni)	0.1	20.6	22.7	18.7	18.7	28.5	24.1	22.7	17.2	21.9	25.2	20.3	26.2
Niobium (Nb)	0.1	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	0.06
Phosphorus (P)	10	320	840	830	150	430	530	730	340	230	670	880	220
Rhenium (Re)	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium (Rb)	0.1	12.7	8.1	9.6	18.5	9.6	10	8	14.6	14.5	10.4	14.6	12.5
Scandium (Sc)	0.1	5.8	7.5	8.2	5.5	6.6	7.2	7.4	4.6	7.1	7.5	6.4	5.7
Selenium (Se)	1	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.6	0.3	0.3	0.6	0.4
Silver (Ag)	0.1	0.08	0.07	0.06	0.06	0.04	0.12	0.09	0.09	0.05	0.05	0.1	0.1
Strontium (Sr)	0.1	88.6	92.9	168.5	49.9	90.7	96.8	88.4	74.6	74.9	83.6	104	40.5
Sulfur (S)	100	100	200	300	100	100	200	300	1700	100	200	1000	200
Tantalum (Ta)	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium (Te)	0.05	0.04	0.05	0.04	0.03	0.04	0.06	0.08	0.07	0.03	0.06	0.06	0.04
Thorium (Th)	0.1	3.6	3.9	3.9	2.5	2.8	3.8	4.6	2.4	2.5	3.4	3.8	3.3
Titanium (Ti)	0.005	<0.005	<0.005	<0.005	50	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	90
Thallium (Tl)	0.1	0.08	0.05	0.06	0.13	0.06	0.06	0.04	0.02	0.1	0.07	0.04	0.11
Tin (Sn)	0.1	0.8	0.8	0.6	0.7	0.8	0.9	1.2	0.7	0.8	0.9	0.7	0.6
Tungsten (W)	0.1	0.18	0.08	<0.05	0.24	0.13	0.05	<0.05	<0.05	0.15	<0.05	<0.05	0.29
Uranium (U)	0.1	0.49	0.57	0.41	0.29	0.39	0.54	0.6	0.38	0.44	0.54	0.44	0.59
Vanadium (V)	1	45	45	44	61	44	36	40	24	57	39	31	89
Yttrium (Y)	0.1	8.88	10.35	11	8.09	8.95	9.46	11.1	4.94	9.94	10.75	8.45	8.52
Zinc (Zn)	0.5	54	81	71	31	66	84	86	83	53	82	82	36
Zirconium (Zr)	0.5	4.9	7	6.3	4.7	4.7	6	6.9	5.1	4	6.2	4.3	5.7
Zinc (Zn)	5	54	81	71	31	66	84	86	83	53	82	82	36

Notes: < indicates less than the laboratory lin

Table B2: Whole rock multi-element analysis results for Broadmeadow East

RGS Sample Number →		2020057_C1115	2020057_C1116	2020057_C1117	2020057_C1118	2020057_C1119	2020057_C1120	2020057_C1121	2020057_C1122	2020057_C1123	2020057_C1124	2020057_C1125	2020057_C1126
Sampling Date →		7/05/2021	8/05/2021	9/05/2021	10/05/2021	11/05/2021	12/05/2021	13/05/2021	14/05/2021	15/05/2021	16/05/2021	17/05/2021	18/05/2021
ALS Laboratory ID →		EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627
Parameters	Limit of Reporting	**SLT**	**SS/SLT**	**SLT**	**XSLT/SLT**	**TOPSOIL/SLT**	**SLT/SS**	**SLT/SS**	**SLT**	**XSLT**	**COAL**	**COAL**	**COAL/SLT**
Major Cations													
Calcium (Ca)	50	8300	23400	15600	9200	1100	15600	17400	21100	5200	8100	5000	3900
Magnesium (Mg)	50	6000	5000	5800	3700	1600	4400	5600	5600	4800	2200	2100	5600
Potassium (K)	50	2200	1600	1800	1400	800	1700	1400	1800	1800	1300	1200	2400
Sodium (Na)	50	2100	1000	1000	1000	1100	900	600	600	600	400	400	600
Major, Minor and Trace Elements													
Aluminium (Al)	50	22500	18400	17400	14300	9400	17400	14500	17100	11300	8000	6900	15800
Antimony (Sb)	0.1	0.37	0.2	0.13	0.57	0.25	0.24	0.25	0.16	0.86	0.43	0.32	0.82
Arsenic (As)	0.1	7.6	4.4	2.8	18.7	7	7.3	9.5	8	17.8	7.9	6.2	31.7
Barium (Ba)	0.1	400	100	100	160	190	100	80	50	120	70	100	140
Beryllium (Be)	0.1	1.22	0.89	1.35	1.52	0.86	0.92	1.15	0.95	1.17	0.69	0.54	0.98
Bismuth (Bi)	0.1	0.28	0.16	0.37	0.47	0.1	0.16	0.3	0.19	0.38	0.26	0.26	0.37
Boron (B)	50	10	<10	<10	<10	10	10	<10	<10	<10	<10	<10	<10
Cadmium (Cd)	0.1	0.09	0.08	0.12	0.13	<0.01	0.05	0.14	0.08	0.1	0.08	0.08	0.11
Caesium (Cs)	0.05	1.81	1.44	2.4	3.11	1	1.33	1.6	1.46	4.28	2.06	1.89	4.6
Cerium (Ce)	0.01	13.65	11.25	17.95	17.1	14.95	12.6	15.35	11.15	14.9	8.91	8.5	9.22
Chromium (Cr)	0.1	20	21	16	12	90	27	18	20	12	7	8	11
Cobalt (Co)	0.1	17.6	16.6	17	14.7	11.2	15.6	17	16.4	14.7	8.4	6.8	19
Copper (Cu)	0.1	41	23.3	44.5	48.9	19.7	22.4	43	27.6	46.8	36.6	36.3	48.5
Gallium (Ga)	0.05	7.84	6.58	6.45	5.05	3.98	6.37	5.85	5.38	4.1	2.08	1.64	5.13
Germanium (Ge)	0.05	0.06	0.06	0.07	0.06	0.08	0.06	0.06	0.05	0.06	0.06	<0.05	<0.05
Gold (Au)	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Hafnium (Hf)	0.1	0.16	0.14	0.15	0.16	0.18	0.13	0.16	0.14	0.13	0.12	0.1	0.11
Indium (In)	0.005	0.041	0.036	0.049	0.074	0.032	0.033	0.047	0.034	0.055	0.05	0.043	0.061
Iron (Fe)	50	42300	39400	40700	38200	63300	38100	43300	37400	50600	36700	17400	25300
Lanthanum (La)	0.5	4.7	3.8	6.8	6.6	6.6	4.6	5.7	4.1	5.3	3.2	3.2	3.6
Lead (Pb)	0.1	16.3	10.9	29.6	26.7	9	11.5	20	14.4	19.3	11.9	11.4	21.9
Lithium (Li)	0.1	13.8	9.4	10.6	12	2.7	10.4	9.4	9.6	9.5	6.3	5.3	12.4
Manganese (Mn)	0.1	702	816	870	825	313	640	770	749	1040	528	303	213
Mercury (Hg)	0.005	0.01	<0.01	0.01	0.07	<0.01	0.01	0.03	0.01	0.07	0.07	0.07	0.09
Molybdenum (Mo)	0.1	0.25	0.1	0.18	1.15	1.07	0.25	0.52	0.22	1.33	1.92	1.21	1.02
Nickel (Ni)	0.1	25.3	24.8	25.9	20	23.4	24.6	23.4	24.4	22.2	14.6	12.1	28.5
Niobium (Nb)	0.1	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phosphorus (P)	10	850	450	910	1160	160	360	750	440	1080	2440	1420	560
Rhenium (Re)	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Rubidium (Rb)	0.1	14.9	10.6	12.9	9.9	11	12.6	9.3	11.4	12.4	7.9	6.9	14.8
Scandium (Sc)	0.1	7.4	7	8.2	6.8	5.1	6.6	7.6	6.4	6	5.1	3.8	4.6
Selenium (Se)	1	0.3	0.2	0.3	0.4	0.4	0.2	0.2	0.2	0.6	0.8	0.6	0.5
Silver (Ag)	0.1	0.03	0.05	0.1	0.09	0.02	0.03	0.07	0.06	0.09	0.05	0.05	0.11
Strontium (Sr)	0.1	52.8	86.7	131.5	128.5	27.8	63.6	103	100.5	78.8	92.7	71.7	78.6
Sulfur (S)	100	300	1100	200	400	200	100	200	300	1600	10300	5900	1500
Tantalum (Ta)	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium (Te)	0.05	0.04	0.04	0.05	0.08	0.03	0.03	0.05	0.03	0.06	0.06	0.06	0.07
Thorium (Th)	0.1	3.4	2	2.8	4.4	3.5	2.5	3.7	2.3	4.3	2.1	2.1	3.6
Titanium (Ti)	0.005	<0.005	<0.005	<0.005	<0.005	140	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Thallium (Tl)	0.1	0.08	0.07	0.07	0.04	0.06	0.06	0.06	0.07	0.04	<0.02	<0.02	0.04
Tin (Sn)	0.1	0.9	0.7	0.9	1.1	0.5	0.8	0.8	0.7	0.7	0.5	0.4	0.7
Tungsten (W)	0.1	0.06	0.11	<0.05	<0.05	0.51	0.53	0.07	0.37	0.06	0.09	0.06	<0.05
Uranium (U)	0.1	0.5	0.33	0.56	0.66	0.36	0.41	0.48	0.34	0.52	0.45	0.36	0.35
Vanadium (V)	1	49	46	38	34	111	54	44	44	31	23	19	31
Yttrium (Y)	0.1	13.9	10.7	13.85	11.1	8.31	9.57	9.87	8.91	10.65	10.15	6.56	5.57
Zinc (Zn)	0.5	79	63	79	86	31	57	82	69	83	52	52	113
Zirconium (Zr)	0.5	5.2	4.2	5.4	6.2	6.9	4.6	6.3	4.5	4.7	4.5	3.5	3.8
Zinc (Zn)	5	79	63	79	86	31	57	82	69	83	52	52	113

Notes: < indicates less than the laboratory lin

Table B2: Whole rock multi-element analysis results for Broadmeadow East

RGS Sample Number →		2020057_C1127	2020057_C1128	2020057_C1129	2020057_C1130	2020057_C1131	2020057_C1132	2020057_C1133	2020057_C1134	2020057_C3007	2020057_C3008	2020057_C3009
Sampling Date →		19/05/2021	20/05/2021	21/05/2021	22/05/2021	23/05/2021	24/05/2021	25/05/2021	26/05/2021	27/05/2021	28/05/2021	29/05/2021
ALS Laboratory ID →		EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627	EB2112627
Parameters	Limit of Reporting	**XMS**	**TOPSOIL/SLT**	**SLT**	**SLT**	**XSLT/SLT**	**XSLT**	**XSLT**	**COAL**	**COAL (COAL SAMPLES)**	**COAL (COAL SAMPLES)**	**COAL (COAL SAMPLES)**
Major Cations												
Calcium (Ca)	50	5200	300	8700	19500	14600	6300	3700	16700	25100	26000	2200
Magnesium (Mg)	50	4800	200	3200	5100	5400	5600	3000	900	4500	1900	3900
Potassium (K)	50	2400	300	1400	1300	2700	2300	1700	500	2000	400	2400
Sodium (Na)	50	500	200	600	400	400	400	400	200	1200	800	2100
Major, Minor and Trace Elements												
Aluminium (Al)	50	13700	7400	12700	14000	16500	13800	10100	4300	13600	5700	11500
Antimony (Sb)	0.1	0.9	0.35	0.12	0.26	0.56	0.95	0.54	0.14	0.82	0.13	0.24
Arsenic (As)	0.1	12	9.2	6	11.2	18.1	20.5	11.4	2.3	14.8	1.5	4.9
Barium (Ba)	0.1	140	140	270	110	130	130	110	50	330	300	1160
Beryllium (Be)	0.1	1.07	0.21	1.32	1.19	1.29	1.32	0.81	0.38	1.17	0.39	1.02
Bismuth (Bi)	0.1	0.44	0.12	0.16	0.28	0.28	0.35	0.33	0.14	0.4	0.13	0.36
Boron (B)	50	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium (Cd)	0.1	0.14	<0.01	0.08	0.08	0.08	0.09	0.11	0.04	0.13	0.05	0.13
Caesium (Cs)	0.05	3.53	0.48	1.98	1.32	3.32	4.15	4.42	0.82	5	0.53	4.7
Cerium (Ce)	0.01	11.8	4.17	21.3	15.25	18.6	19.35	8.2	6.45	13.45	8.72	7.81
Chromium (Cr)	0.1	11	45	17	17	13	11	9	3	10	6	8
Cobalt (Co)	0.1	20.5	1.8	27.1	14.5	14.7	13.8	12.8	2.5	13.2	5	9.1
Copper (Cu)	0.1	55.9	14.9	25.1	32.5	42.5	45.4	45.4	19.4	50.7	22	58.1
Gallium (Ga)	0.05	4.68	3.11	4.73	5.26	5.41	4.57	2.63	0.98	4.13	1.16	3.57
Germanium (Ge)	0.05	0.05	0.05	0.07	0.06	0.06	0.07	<0.05	0.08	0.06	0.09	<0.05
Gold (Au)	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Hafnium (Hf)	0.1	0.13	0.1	0.11	0.16	0.13	0.13	0.11	0.09	0.12	0.08	0.09
Indium (In)	0.005	0.064	0.037	0.032	0.053	0.053	0.055	0.056	0.024	0.061	0.026	0.05
Iron (Fe)	50	42600	50200	34200	43200	45200	56900	12000	17200	26500	28200	11600
Lanthanum (La)	0.5	4.2	1.6	5.9	5.5	6.7	7	3	2.4	4.9	3.4	3.5
Lead (Pb)	0.1	26.3	4	11.5	21.8	17.9	19.5	17.6	4.7	20.5	4.4	16.7
Lithium (Li)	0.1	10.6	2.1	8.7	7.6	10.6	9.6	9.3	3.3	11.5	4.8	8.4
Manganese (Mn)	0.1	764	25	833	768	733	1270	123	234	492	518	102
Mercury (Hg)	0.005	0.12	0.01	0.01	0.03	0.05	0.08	0.09	0.03	0.11	0.31	0.23
Molybdenum (Mo)	0.1	2.71	3.08	0.2	0.59	0.88	1.4	0.92	0.82	2.11	0.74	1.18
Nickel (Ni)	0.1	34.4	3.6	30.1	21.2	23.2	23.9	19.9	4.4	21	10.9	18.9
Niobium (Nb)	0.1	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05
Phosphorus (P)	10	960	170	380	760	1190	1350	1030	1840	2360	2390	270
Rhenium (Re)	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	<0.001
Rubidium (Rb)	0.1	13.2	3.5	12.8	8.8	16.7	15	11.2	3.6	13.5	2.3	14
Scandium (Sc)	0.1	5.6	4.8	6.6	7.7	7.3	7.2	5.1	2.5	6.1	3.1	3.6
Selenium (Se)	1	0.8	0.9	0.4	0.3	0.4	0.6	0.8	0.5	0.8	0.6	0.6
Silver (Ag)	0.1	0.11	0.01	0.03	0.06	0.08	0.09	0.08	0.02	0.11	0.02	0.09
Strontium (Sr)	0.1	77	6	30.9	85.5	90.3	76.3	75.1	92.5	159.5	154	154
Sulfur (S)	100	4000	200	200	200	500	1200	2800	19000	2000	5500	2200
Tantalum (Ta)	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium (Te)	0.05	0.09	0.03	0.02	0.05	0.05	0.06	0.06	0.03	0.07	0.03	0.07
Thorium (Th)	0.1	4.4	2.3	2.3	3.4	4.6	4.4	2.2	1.4	5.2	1.3	1.6
Titanium (Ti)	0.005	<0.005	80	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Thallium (Tl)	0.1	0.04	0.02	0.07	0.05	0.05	0.05	<0.02	<0.02	0.02	<0.02	0.07
Tin (Sn)	0.1	0.7	0.4	0.7	0.9	0.7	0.7	0.6	0.3	0.7	0.3	0.5
Tungsten (W)	0.1	<0.05	0.23	0.49	0.09	0.12	0.05	<0.05	0.09	<0.05	<0.05	<0.05
Uranium (U)	0.1	0.47	0.33	0.47	0.49	0.6	0.55	0.34	0.29	0.94	0.3	0.31
Vanadium (V)	1	32	205	43	52	38	33	24	10	26	13	18
Yttrium (Y)	0.1	10.25	1.15	13.9	10.15	13.1	14.05	6.89	5.85	13.1	8.13	3.47
Zinc (Zn)	0.5	99	40	74	76	86	85	75	18	84	21	70
Zirconium (Zr)	0.5	4.2	3.9	3.8	5.8	5.4	5.2	3.7	3.1	4.1	3.1	3.1
Zinc (Zn)	5	99	40	74	76	86	85	75	18	84	21	70

Notes: < indicates less than the laboratory lin

9.2.3 Table B3: Multi-element test results for water extracts

Table B3: Water extract multi-element analysis results for Broadmeadow East

RGS Sample Number →		2020057_C1103	2020057_C1104	2020057_C1105	2020057_C1106	2020057_C1107	2020057_C1108	2020057_C1109	2020057_C1110	2020057_C1111	2020057_C1112	2020057_C1113	2020057_C1114	2020057_C1115	2020057_C1116
Sample Date →		07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021
ALS Laboratory ID →		EB2112627001	EB2112627002	EB2112627003	EB2112627004	EB2112627005	EB2112627006	EB2112627007	EB2112627008	EB2112627009	EB2112627010	EB2112627011	EB2112627012	EB2112627013	EB2112627014
Parameters	Limit of Reporting	Topsoil	SLT	SS/SLT	Topsoil	SLT/SS	SLT	XSS	XSS/SLT	TOPSOIL	SLT	XLST/SLT	TOPSOIL/SLT	SLT	SS/SLT
pH	0.01 pH unit	8.13	8.65	8.93	8.28	8.36	8.37	8.48	8.28	8.16	8.21	8.36	8.31	8.2	8.3
Electrical Conductivity	1 µS/cm	808	740	548	670	778	847	666	645	292	568	484	867	940	834
Carbonate Alkalinity (mgCaCO$_3$/L)	1 mg/L	0	3	5	0	0	1	1	0	0	0	0	0	0	0
Bicarbonate Alkalinity (mgCaCO$_3$/L)	1 mg/L	28	21	23	28	17	22	22	20	17	17	24	30	32	22
Total Alkalinity (mgCaCO$_3$/L)	1 mg/L	28	24	28	28	17	23	23	20	17	17	24	30	32	22
Acidity (mgCaCO$_3$/L)	1 mg/L	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Alkalinity (mgCaCO$_3$/L)	1 mg/L	28	24	28	28	17	23	23	20	17	17	24	30	32	22
Major Ions	All units mg/L														
Calcium (Ca)	2	0.4	0.2	0.1	0.4	0.4	0.4	0.4	0.2	1.4	1	0.4	0.4	0.2	0.6
Magnesium (Mg)	2	0.2	0.1	0.1	0.4	0.4	0.4	0.4	0.2	1.2	1	0.4	0.4	0.2	0.6
Potassium (K)	2	0.4	0.4	1	0.4	0.4	0.8	0.8	0.8	0.2	0.4	1.2	0.2	0.2	1
Sodium (Na)	2	31.6	28.8	21.6	26.6	32.4	24.4	25.8	25.2	9.2	20	20.6	34.8	39.8	32.2
Chloride (Cl)	2	33.2	28	12.6	22.8	36.8	37.6	22	11	7.6	21.6	2.2	32.6	33.8	36.2
Fluoride (F)	0.2	0.56	0.22	0.1	0.4	0.42	0.14	0.12	0.12	0.54	0.32	0.08	0.46	0.44	0.08
Sulfate (SO$_4$)	2	3.4	6	7	3.8	3	5.6	8.4	24.6	0.2	4.6	20	6.8	11.6	6.2
Silica (Si)	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nitrite + Nitrate as N	0.002	0.2	0.008	0.002	0.446	0.008	0.052	0.006	0.001	0.028	0.006	0.001	0.032	0.002	0.036
Total Kjeldahl Nitrogen as N	0.02	0.08	0.01	0.06	0.12	0.01	0.01	0.01	0.02	0.01	0.01	0.04	0.04	0.02	0.01
Total Nitrogen as N	0.02	0.28	0.01	0.06	0.56	0.01	0.06	0.01	0.02	0.02	0.01	0.04	0.08	0.02	0.04
Total Phosphorus as P	0.002	0.026	0.012	0.024	0.008	0.002	0.002	0.008	0.006	0.002	0.002	0.004	0.008	0.008	0.004
Reactive Phosphorus as P	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Trace Metals/Metalloids	All units mg/L														
Aluminium (Al)	0.01	0.816	0.286	0.872	0.88	0.196	0.17	0.314	0.334	0.256	0.196	0.46	0.52	0.254	0.242
Antimony (Sb)	0.001	0.0001	0.0006	0.0008	0.0001	0.0001	0.0002	0.0012	0.0024	0.0001	0.0001	0.0024	0.0001	0.0002	0.0002
Arsenic (As)	0.001	0.0002	0.0022	0.0314	0.0006	0.0001	0.0006	0.0092	0.007	0.0002	0.0006	0.004	0.0004	0.0006	0.0012
Barium (Ba)	0.001	0.286	0.107	0.1252	0.234	0.1374	0.1144	0.1212	0.1174	0.1664	0.1728	0.1484	0.222	0.1168	0.1742
Beryllium (Be)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Bismuth (Bi)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Boron (B)	0.05	0.534	0.334	0.07	0.206	0.08	0.046	0.048	0.074	0.062	0.052	0.054	0.208	0.136	0.122
Cadmium (Cd)	0.0001	0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002	0.00002	0.00001	0.00001
Caesium (Cs)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cerium (Ce)	0.001	0.0006	0.0001	0.0001	0.0004	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium (Cr)	0.001	0.0006	0.0002	0.0006	0.0008	0.0004	0.0002	0.0004	0.0002	0.0004	0.0002	0.0002	0.0008	0.0002	0.0002
Cobalt (Co)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Copper (Cu)	0.001	0.0012	0.0008	0.0004	0.001	0.0002	0.0001	0.0004	0.001	0.0006	0.0018	0.0002	0.0018	0.0004	0.0001
Dysprosium (Dy)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Erbium (Er)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Europium (Eu)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Gadolinium (Gd)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Gallium (Ga)	0.001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Hafnium (Hf)	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Holmium (Ho)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Indium (In)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Iron (Fe)	0.05	0.308	0.036	0.09	0.364	0.052	0.028	0.036	0.048	0.118	0.04	0.104	0.216	0.074	0.048
Lanthanum (La)	0.001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Lead (Pb)	0.001	0.0004	0.0001	0.0002	0.0004	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001
Lithium (Li)	0.001	0.0004	0.0008	0.0012	0.0004	0.0004	0.001	0.0016	0.0012	0.0002	0.0012	0.0016	0.0002	0.0004	0.0006
Lutetium (Lu)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Manganese (Mn)	0.001	0.0042	0.0006	0.0008	0.0044	0.0034	0.0012	0.001	0.0014	0.002	0.0018	0.0012	0.0022	0.0008	0.001
Mercury (Hg)	0.0001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Molybdenum (Mo)	0.001	0.0004	0.0032	0.011	0.0006	0.0004	0.001	0.007	0.0282	0.0004	0.0064	0.0282	0.001	0.0022	0.0002
Neodymium (Nd)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Nickel (Ni)	0.001	0.0004	0.0001	0.0002	0.0004	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001
Praseodymium (Pr)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Rubidium (Rb)	0.001	0.0012	0.0006	0.0016	0.001	0.0006	0.0008	0.0008	0.001	0.0004	0.0006	0.0014	0.0006	0.0006	0.0012
Samarium (Sm)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Selenium (Se)	0.01	0.001	0.002	0.004	0.001	0.001	0.001	0.004	0.008	0.001	0.001	0.008	0.001	0.001	0.001
Silver (Ag)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Strontium (Sr)	0.001	0.0088	0.0056	0.008	0.0114	0.0082	0.0138	0.0138	0.0092	0.0262	0.0272	0.023	0.0114	0.0062	0.0226
Tellurium (Te)	0.005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Terbium (Tb)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium (Tl)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thorium (Th)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thulium ™	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Tin (Sn)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Titanium (Ti)	0.01	0.018	0.008	0.028	0.022	0.002	0.006	0.01	0.008	0.01	0.008	0.01	0.016	0.006	0.006
Uranium (U)	0.001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0004	0.0001	0.0001
Vanadium (V)	0.01	0.004	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Ytterbium (Yb)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Yttrium (Y)	0.001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Zinc (Zn)	0.005	0.1434	0.0166	0.0148	0.0788	0.0136	0.0076	0.0096	0.0116	0.0146	0.013	0.0148	0.0716	0.0218	0.0618
Zirconium (zr)	0.005	0.001	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005

Notes: < indicates concentration less than the detection limit.

Table B3: Water extract multi-element analysis results for Broadmeadow East

RGS Sample Number →		2020057_C1117	2020057_C1118	2020057_C1119	2020057_C1120	2020057_C1121	2020057_C1122	2020057_C1123	2020057_C1124	2020057_C1125	2020057_C1126	2020057_C1127	2020057_C1128	2020057_C1129	2020057_C1130
Sample Date →		07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021
ALS Laboratory ID →		EB2112627015	EB2112627016	EB2112627017	EB2112627018	EB2112627019	EB2112627020	EB2112627021	EB2112627022	EB2112627023	EB2112627024	EB2112627025	EB2112627026	EB2112627027	EB2112627028
Parameters	Limit of Reporting	SLT	XSLT/SLT	TOPSOIL/SLT	SLT/SS	SLT/SS	SLT	XSLT	COAL	COAL	COAL/SLT	XMS	TOPSOIL/SLT	SLT	SLT
pH	0.01 pH unit	8.6	8.6	8.1	8.4	8.4	8.6	8.3	7.6	7.5	8.1	8.2	7.1	8.2	8.2
Electrical Conductivity	1 µS/cm	496	452	428	497	383	390	499	1380	1130	413	729	122	383	285
Carbonate Alkalinity (mgCaCO$_3$/L)	1 mg/L	3	2	0	1	1	2	0	0	0	0	0	0	0	0
Bicarbonate Alkalinity (mgCaCO$_3$/L)	1 mg/L	34	23	14	24	24	21	23	6	6	14	21	1	21	18
Total Alkalinity (mgCaCO$_3$/L)	1 mg/L	37	26	14	25	25	23	23	6	6	14	21	1	21	18
Acidity (mgCaCO$_3$/L)	1 mg/L	0	0	0	0	0	0	1	1	1	0	0	0	0	0
Net Alkalinity (mgCaCO$_3$/L)	1 mg/L	37	26	14	25	25	23	23	6	6	14	21	1	21	18
Major Ions														All units mg/L	
Calcium (Ca)	2	0.4	0.4	0.4	0.2	0.2	0.1	2	38.8	30.6	2.2	6.4	0.1	1.8	1
Magnesium (Mg)	2	0.2	0.1	0.2	0.2	0.2	0.1	1.6	17.4	13	1	4.2	0.1	1.4	1
Potassium (K)	2	0.8	0.6	0.4	0.4	1	1	1.8	1.4	1.6	2.4	2.2	0.1	0.8	1.2
Sodium (Na)	2	22	19.8	16.6	19.8	16.2	16.4	15.2	9	8.4	23	15.6	4.2	11.4	8.6
Chloride (Cl)	2	6.8	4.8	15.6	15.4	5.6	7.2	4.2	0.8	0.2	3.4	1.8	5.2	7.6	2.6
Fluoride (F)	0.2	0.08	0.08	0.26	0.24	0.1	0.1	0.08	0.04	0.04	0.08	0.06	0.04	0.26	0.16
Sulfate (SO$_4$)	2	3.6	12.4	3.4	2.6	5.2	4.8	20	153.8	121	19.2	49.4	2	5.4	6
Silica (Si)	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nitrite + Nitrate as N	0.002	0.258	0.096	0.186	0.072	0.012	0.306	0.012	0.001	0.001	0.012	0.416	0.442	0.024	0.001
Total Kjeldahl Nitrogen as N	0.02	0.08	0.01	0.12	0.08	0.02	0.04	0.02	0.04	0.01	0.04	0.08	0.08	0.01	0.01
Total Nitrogen as N	0.02	0.34	0.1	0.3	0.16	0.04	0.34	0.04	0.04	0.01	0.06	0.5	0.52	0.02	0.01
Total Phosphorus as P	0.002	0.008	0.064	0.04	0.016	0.008	0.006	0.001	0.001	0.001	0.01	0.002	0.006	0.004	0.004
Reactive Phosphorus as P	0.002	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004
Trace Metals/Metalloids														All units mg/L	
Aluminium (Al)	0.01	0.418	0.97	0.798	0.61	0.998	0.604	0.234	0.05	0.046	0.484	0.02	0.05	0.168	0.296
Antimony (Sb)	0.001	0.0001	0.0022	0.0001	0.0001	0.0006	0.0004	0.0012	0.0001	0.0001	0.0054	0.0006	0.0001	0.0001	0.0006
Arsenic (As)	0.001	0.0006	0.0094	0.0006	0.0002	0.004	0.006	0.0004	0.0001	0.0001	0.0268	0.0004	0.0001	0.0001	0.0028
Barium (Ba)	0.001	0.1858	0.1914	0.3	0.292	0.21	0.1824	0.268	0.0092	0.0084	0.236	0.1174	0.1338	0.228	0.1956
Beryllium (Be)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Bismuth (Bi)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Boron (B)	0.05	0.13	0.118	0.154	0.142	0.09	0.1	0.09	0.018	0.014	1.078	0.072	0.07	0.068	0.072
Cadmium (Cd)	0.0001	0.00001	0.00001	0.00004	0.00002	0.00001	0.00001	0.00002	0.00008	0.00006	0.00004	0.00006	0.00001	0.00002	0.00001
Caesium (Cs)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0004	0.0001	0.0001	0.0001	0.0001
Cerium (Ce)	0.001	0.0001	0.0001	0.002	0.0004	0.0002	0.0001	0.0001	0.0001	0.0001	0.0006	0.0001	0.0001	0.0001	0.0001
Chromium (Cr)	0.001	0.0004	0.0006	0.001	0.0006	0.0016	0.0004	0.0004	0.0001	0.0001	0.0036	0.0001	0.0001	0.0002	0.0002
Cobalt (Co)	0.001	0.0001	0.0001	0.001	0.0004	0.0001	0.0001	0.0001	0.0086	0.0042	0.0006	0.0004	0.0002	0.0001	0.0001
Copper (Cu)	0.001	0.0028	0.0008	0.0016	0.001	0.0008	0.0006	0.0004	0.0001	0.0001	0.0044	0.0006	0.0004	0.0004	0.0008
Dysprosium (Dy)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Erbium (Er)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Europium (Eu)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Gadolinium (Gd)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Gallium (Ga)	0.001	0.0001	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Hafnium (Hf)	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Holmium (Ho)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Indium (In)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Iron (Fe)	0.05	0.18	0.142	0.434	0.338	0.17	0.192	0.038	0.005	0.005	0.146	0.005	0.014	0.05	0.046
Lanthanum (La)	0.001	0.0001	0.0001	0.0006	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001
Lead (Pb)	0.001	0.0008	0.0038	0.0066	0.0024	0.0012	0.0014	0.0006	0.0001	0.0001	0.0042	0.0006	0.0001	0.0012	0.0006
Lithium (Li)	0.001	0.0008	0.0016	0.0004	0.0004	0.0012	0.0004	0.0024	0.0086	0.0062	0.002	0.0036	0.0026	0.0004	0.0008
Lutetium (Lu)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Manganese (Mn)	0.001	0.0018	0.0006	0.031	0.0092	0.0012	0.0012	0.0042	0.85	0.464	0.0096	0.0132	0.0026	0.0032	0.0012
Mercury (Hg)	0.0001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Molybdenum (Mo)	0.001	0.0004	0.0126	0.0002	0.0004	0.0032	0.0006	0.013	0.0001	0.0001	0.0462	0.0184	0.0002	0.0004	0.0036
Neodymium (Nd)	0.001	0.0001	0.0001	0.0008	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001
Nickel (Ni)	0.001	0.0001	0.0004	0.0008	0.0006	0.0004	0.0002	0.0001	0.0184	0.009	0.0026	0.0006	0.0001	0.0001	0.0001
Praseodymium (Pr)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Rubidium (Rb)	0.001	0.001	0.0014	0.0008	0.001	0.0016	0.0014	0.0016	0.0014	0.0012	0.0022	0.0016	0.0001	0.0006	0.0012
Samarium (Sm)	0.001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Selenium (Se)	0.01	0.001	0.008	0.001	0.001	0.002	0.001	0.006	0.004	0.004	0.012	0.008	0.001	0.001	0.002
Silver (Ag)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Strontium (Sr)	0.001	0.0142	0.0076	0.009	0.0068	0.0092	0.0064	0.0726	0.434	0.43	0.0494	0.206	0.006	0.0244	0.0292
Tellurium (Te)	0.005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Terbium (Tb)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium (Tl)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thorium (Th)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thulium ™	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Tin (Sn)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Titanium (Ti)	0.01	0.012	0.026	0.018	0.018	0.038	0.022	0.006	0.004	0.002	0.008	0.001	0.001	0.01	0.01
Uranium (U)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001
Vanadium (V)	0.01	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Ytterbium (Yb)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Yttrium (Y)	0.001	0.0001	0.0001	0.0006	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Zinc (Zn)	0.005	0.0686	0.0182	0.0366	0.0636	0.0368	0.04	0.0308	0.025	0.0184	0.0276	0.0172	0.0092	0.0176	0.0144
Zirconium (zr)	0.005	0.0005	0.0012	0.0005	0.0005	0.0012	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005

Notes: < indicates concentration less than the detection

Table B3: Water extract multi-element analysis results for Broadmeadow East

	RGS Sample Number →	2020057_C1131	2020057_C1132	2020057_C1133	2020057_C1134	2020057_C3007	2020057_C3008	2020057_C3009
	Sample Date →	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021
	ALS Laboratory ID →	EB2112627029	EB2112627030	EB2112627031	EB2112627032	EB2112627033	EB2112627034	EB2112627035
Parameters	Limit of Reporting	XSLT/SLT	XSLT	XSLT	COAL	COAL (COAL SAMPLES)	COAL (COAL SAMPLES)	COAL (COAL SAMPLES)
pH	0.01 pH unit	8.3	8.3	7.9	7.8	8.4	8.1	8.2
Electrical Conductivity	1 µS/cm	382	464	753	1340	658	627	549
Carbonate Alkalinity (mg$CaCO_3$/L)	1 mg/L	0	0	0	0	1	0	0
Bicarbonate Alkalinity (mg$CaCO_3$/L)	1 mg/L	23	26	11	9	24	16	16
Total Alkalinity (mg$CaCO_3$/L)	1 mg/L	23	26	11	9	25	16	16
Acidity (mg$CaCO_3$/L)	1 mg/L	0	0	0	1	0	0	0
Net Alkalinity (mg$CaCO_3$/L)	1 mg/L	23	26	11	9	25	16	16
Major Ions								
Calcium (Ca)	2	2	3	8.8	45.6	0.6	5.4	0.1
Magnesium (Mg)	2	2.4	3.2	7	6.8	0.6	2.2	0.1
Potassium (K)	2	2.2	2.2	2.4	1.2	1	1	0.6
Sodium (Na)	2	9.4	9.6	10.4	4.2	25.4	19.8	21
Chloride (Cl)	2	2.4	2.4	1.6	0.6	12.6	5.4	11.8
Fluoride (F)	0.2	0.12	0.1	0.06	0.04	0.12	0.04	0.12
Sulfate (SO_4)	2	11.2	17.4	64.6	143.6	19.4	36.6	16.8
Silica (Si)	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nitrite + Nitrate as N	0.002	0.348	0.001	0.224	0.001	0.004	0.002	0.012
Total Kjeldahl Nitrogen as N	0.02	0.04	0.02	0.04	0.01	0.04	0.04	0.1
Total Nitrogen as N	0.02	0.38	0.02	0.26	0.01	0.04	0.04	0.12
Total Phosphorus as P	0.002	0.002	0.001	0.001	0.001	0.006	0.004	0.024
Reactive Phosphorus as P	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.002
Trace Metals/Metalloids								
Aluminium (Al)	0.01	0.092	0.042	0.022	0.012	0.444	0.068	0.336
Antimony (Sb)	0.001	0.001	0.0008	0.0004	0.0001	0.003	0.0001	0.0016
Arsenic (As)	0.001	0.0006	0.0002	0.0001	0.0001	0.0038	0.0001	0.025
Barium (Ba)	0.001	0.22	0.204	0.0962	0.0098	0.1654	0.0214	0.1498
Beryllium (Be)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Bismuth (Bi)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Boron (B)	0.05	0.066	0.078	0.074	0.018	0.072	0.02	0.09
Cadmium (Cd)	0.0001	0.00002	0.00004	0.00006	0.00001	0.00004	0.00001	0.00002
Caesium (Cs)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cerium (Ce)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium (Cr)	0.001	0.0018	0.0001	0.0001	0.0001	0.0002	0.0001	0.0002
Cobalt (Co)	0.001	0.0001	0.0001	0.0016	0.0002	0.0001	0.0001	0.0001
Copper (Cu)	0.001	0.0014	0.0028	0.0016	0.0001	0.0004	0.0001	0.001
Dysprosium (Dy)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Erbium (Er)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Europium (Eu)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Gadolinium (Gd)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Gallium (Ga)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Hafnium (Hf)	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Holmium (Ho)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Indium (In)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Iron (Fe)	0.05	0.018	0.005	0.005	0.005	0.068	0.026	0.062
Lanthanum (La)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Lead (Pb)	0.001	0.0006	0.0012	0.0012	0.0001	0.0008	0.0001	0.0012
Lithium (Li)	0.001	0.0014	0.002	0.0064	0.0024	0.0016	0.0034	0.0014
Lutetium (Lu)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Manganese (Mn)	0.001	0.003	0.0096	0.03	0.0454	0.001	0.005	0.0006
Mercury (Hg)	0.0001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Molybdenum (Mo)	0.001	0.01	0.0138	0.0026	0.0008	0.0604	0.0086	0.0454
Neodymium (Nd)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Nickel (Ni)	0.001	0.0002	0.0002	0.0024	0.0002	0.0001	0.0006	0.0001
Praseodymium (Pr)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Rubidium (Rb)	0.001	0.0016	0.0016	0.0018	0.0008	0.0014	0.001	0.001
Samarium (Sm)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Selenium (Se)	0.01	0.004	0.004	0.012	0.001	0.012	0.001	0.016
Silver (Ag)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Strontium (Sr)	0.001	0.0816	0.1098	0.262	0.33	0.0294	0.3	0.0126
Tellurium (Te)	0.005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Terbium (Tb)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium (Tl)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thorium (Th)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thulium ™	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Tin (Sn)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Titanium (Ti)	0.01	0.004	0.001	0.001	0.001	0.008	0.004	0.012
Uranium (U)	0.001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
Vanadium (V)	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Ytterbium (Yb)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Yttrium (Y)	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Zinc (Zn)	0.005	0.0118	0.0172	0.0314	0.0186	0.013	0.0148	0.0208
Zirconium (zr)	0.005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005

Notes: < indicates concentration less than the detection

9.2.4 Table B4: Soil fertility results

Table B4: Soil fertility anaysis results for Broadmeadow East

RGS Sample Number →		2020057_C2001	2020057_C2002	2020057_C2003	2020057_C2004	2020057_C2005	2020057_C2006	2020057_C2007	2020057_C2008	2020057_C2009	2020057_C2010	2020057_C2011
Sampling Date →		03/03/2021	03/03/2021	03/03/2021	03/03/2021	03/03/2021	03/03/2021	03/03/2021	03/03/2021	03/03/2021	03/03/2021	03/03/2021
ALS Laboratory ID →		EB2105915001	EB2105915002	EB2105915003	EB2105915004	EB2105915005	EB2105915006	EB2105915007	EB2105915008	EB2105915009	EB2105915010	EB2105915011
Composite Sample ID →		1	2	3	4	5	6	7	8	9	10	11
Parameters	Limit of Reporting	**TOPSOIL**	**SUBSOIL 1**	**SUBSOIL 2**	**REGOLITH**	**TOPSOIL**	**SUBSOIL 1**	**SUBSOIL 2**	**REGOLITH**	**TOPSOIL**	**SUBSOIL 1**	**SUBSOIL 2**
Exchangable Cations												
Exchangeable Calcium	0.2	5.5	2.6	3	1.6	12.1	8.8	7.4	6.3	5.5	5.4	3.4
Exchangeable Magnesium	0.2	3.8	3.6	5.4	3.7	2.8	2.8	2.9	2.5	2	4	4.4
Exchangeable Potassium	0.2	0.6	0.2	0.3	<0.2	0.4	0.2	<0.2	<0.2	0.2	0.3	<0.2
Exchangeable Sodium	0.2	1	1.8	3.4	2.8	<0.2	0.2	0.4	0.3	0.3	0.8	2.3
Cation Exchange Capacity	0.2	10.9	8.2	12	8.3	15.3	12.1	10.8	9.1	8.1	10.5	10.2
Exchangeable Sodium Percent	0.2	9	21.8	28.2	33.6	<0.2	1.9	3.4	3.5	3.5	7.3	22.3
Calcium/Magnesium Ratio	0.2	1.5	0.7	0.5	0.4	4.3	3.2	2.5	2.5	2.7	1.4	0.8
Magnesium/Potassium Ratio	0.2	6.4	14.5	20.5	0	6.4	12	0	0	8.3	13.7	0
Analyte/Metals												
pH (1:5) (pH)	9	9.3	9	8.3	8.7	9.2	9.2	8.6	9	9.2	9.5	7000
EC (1:5) (µS/cm)	212	781	444	83	112	85	82	121	164	218	463	5700
Moisture Content (%)	1	7.1	8.1	8.8	5.9	12.1	7.4	4.8	11.1	8.3	11.5	7.3
Bicarbonate Extractable K (Colwell) (mg/kg)	100	340	188	166	195	211	182	173	160	144	170	109
Chloride (mg/kg)	10	90	440	1110	630	10	20	20	10	40	80	190
Copper (mg/kg)	1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Iron (Fe) (mg/kg)	1	18.3	10.7	8.83	5.82	5.52	4.98	5.52	6.15	9.62	7.76	6.14
Manganese (mg/kg)	1	11.1	6.52	3.73	1.98	6.44	4.98	2.92	3.54	5.76	3.8	4.11
Zinc (mg/kg)	1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Ammonia as N (mg/kg)	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Nitrite as N (Sol.) (mg/kg)	0.1	0.7	0.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate as N (Sol.) (mg/kg)	0.1	8.3	5.3	1.6	0.4	0.9	1.6	0.4	0.3	6	2.5	0.8
Nitrite + Nitrate as N (Sol.) (mg/kg)	0.1	9	6.1	1.6	0.4	0.9	1.6	0.4	0.3	6	2.5	0.8
Total Kjeldahl Nitrogen as N (mg/kg)	20	830	460	310	180	<20	520	220	230	550	390	210
Total Nitrogen as N (mg/kg)	20	840	470	310	180	<20	520	220	230	560	390	210
Total Phosphorus as P (mg/kg)	2	237	245	227	224	172	253	365	410	231	261	253
Bicarbonate Ext. P (Colwell) (mg/kg)	5	7	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Organic Matter (%)	0.5	2.1	1	0.6	<0.5	1.3	0.9	<0.5	<0.5	1.1	0.6	<0.5
Total Organic Carbon (%)	0.5	1.2	0.6	<0.5	<0.5	0.7	0.5	<0.5	<0.5	0.6	<0.5	<0.5

Notes: < indicates less than the laboratory limit of reporting.

Table B4: Soil fertility anaysis results for Broadmeadow East

RGS Sample Number →		2020057_C2012	2020057_C1074	2020057_C1075	2020057_C1076	2020057_C1077	2020057_C1078	2020057_C1079	2020057_C1080	2020057_C1081	2020057_C1082	2020057_C1083
Sampling Date →		03/03/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021
ALS Laboratory ID →		EB2105915012	EB2112584001	EB2112584002	EB2112584003	EB2112584004	EB2112584005	EB2112584006	EB2112584007	EB2112584008	EB2112584009	EB2112584010
Composite Sample ID →		12										
Parameters	Limit of Reporting	**REGOLITH**	**SOIL**	**CLAY**	**CLAY**	**CLAY**	**SLT**	**SOIL**	**SOIL**	**CLAY**	**SLT**	**SLT**
Exchangable Cations	All units meq/100g (except Exchangable Sodium Percentage (%))											
Exchangeable Calcium	0.2	<0.2	0.3	1.1	1.3	0.3	0.4	3.2	1.5	1.1	<0.2	0.8
Exchangeable Magnesium	0.2	<0.2	3.4	5	5.4	3.8	3.2	1.6	2.9	4.6	2.4	3.4
Exchangeable Potassium	0.2	<0.2	<0.2	0.2	<0.2	<0.2	<0.2	0.4	0.2	<0.2	<0.2	<0.2
Exchangeable Sodium	0.2	<0.2	1.5	3	4.2	3.1	2.8	0.2	0.9	2.7	2.3	2.9
Cation Exchange Capacity	0.2	<0.2	5.4	9.3	11.1	7.3	6.5	5.3	5.6	8.6	4.7	7
Exchangeable Sodium Percent	0.2		28.3	32.3	38.1	43	43.4	3	16	31.3	48.4	40.7
Calcium/Magnesium Ratio	0.2		<0.2	<0.2	<0.2	<0.2	<0.2	2	0.5	0.2	<0.2	0.2
Magnesium/Potassium Ratio	0.2		----	21	----	----	----	3.7	14.2	----	----	----
Analyte/Metals												
pH (1:5) (pH)	9	4300	9.3	9.4	9.7	9.7	9.8	7.3	8.3	9.5	9.8	9.6
EC (1:5) (µS/cm)	212	2500	349	651	617	593	498	23	322	468	468	623
Moisture Content (%)	1	9.4	5.9	4.9	9.1	6.4	4.1	3.3	8.2	8.4	6	7.6
Bicarbonate Extractable K (Colwell) (mg/kg)	100	102	146	215	223	193	186	295	165	144	118	166
Chloride (mg/kg)	10	460	200	740	650	630	430	<10	210	360	330	690
Copper (mg/kg)	1	<1.00	1.1	1.22	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Iron (Fe) (mg/kg)	1	5.23	5.11	6.34	4.39	4.13	5.1	10.9	5.44	4.99	6.58	5.26
Manganese (mg/kg)	1	3.31	3.08	2.21	2.65	2.21	3.05	4.8	5.61	2.48	4.52	2.74
Zinc (mg/kg)	1	<1.00	<1.00	1.46	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Ammonia as N (mg/kg)	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Nitrite as N (Sol.) (mg/kg)	0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1
Nitrate as N (Sol.) (mg/kg)	0.1	0.7	0.4	1.9	0.9	0.1	0.9	0.5	1.2	0.7	0.5	0.4
Nitrite + Nitrate as N (Sol.) (mg/kg)	0.1	0.7	0.4	1.9	1.2	0.1	0.9	0.5	1.2	1	0.5	0.4
Total Kjeldahl Nitrogen as N (mg/kg)	20	190	180	180	370	250	230	350	330	160	140	230
Total Nitrogen as N (mg/kg)	20	190	180	180	370	250	230	350	330	160	140	230
Total Phosphorus as P (mg/kg)	2	227	108	118	440	374	380	139	121	98	290	305
Bicarbonate Ext. P (Colwell) (mg/kg)	5	<5	<5	<5	6	<5	<5	<5	<5	<5	<5	<5
Organic Matter (%)	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	0.7	<0.5	<0.5	<0.5
Total Organic Carbon (%)	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5

Notes: < indicates less than the laboratory limit of reporting.

Table B4: Soil fertility anaysis results for Broadmeadow East

RGS Sample Number →		2020057_C1084	2020057_C1085	2020057_C1086	2020057_C1087	2020057_C1088	2020057_C1089	2020057_C1090	2020057_C1091	2020057_C1092	2020057_C1093	2020057_C1094
Sampling Date →		07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021
ALS Laboratory ID →		EB2112584011	EB2112584012	EB2112584013	EB2112584014	EB2112584015	EB2112584016	EB2112584017	EB2112584018	EB2112584019	EB2112584020	EB2112584021
Composite Sample ID →												COAL (COAL
Parameters	Limit of Reporting	**SOIL**	**SLT**	**SLT**	**SLT**	**SLT**	**SOIL**	**SLT**	**SLT**	**SLT**	**SLT**	**SOIL**
Exchangable Cations												
Exchangeable Calcium	0.2	11.4	4.7	2.6	1.6	0.7	3.1	1.2	1	<0.2	<0.2	2
Exchangeable Magnesium	0.2	6.5	3.9	2.8	3.7	2.3	1.6	2	3.8	3.5	3.4	0.4
Exchangeable Potassium	0.2	0.4	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	<0.2	<0.2	0.5
Exchangeable Sodium	0.2	0.6	0.5	0.3	0.8	0.4	0.3	0.9	2.7	2.8	3.4	<0.2
Cation Exchange Capacity	0.2	19	9.2	5.7	6.1	3.4	5.4	4.1	7.6	6.3	6.8	3
Exchangeable Sodium Percent	0.2	3.2	5.6	5.2	12.7	12.7	6.2	21.4	36.1	44	49.8	<0.2
Calcium/Magnesium Ratio	0.2	1.8	1.2	0.9	0.4	0.3	1.9	0.6	0.3	<0.2	<0.2	4.4
Magnesium/Potassium Ratio	0.2	15.6	----	----	----	----	4.9	----	----	----	----	0.9
Analyte/Metals												
pH (1:5) (pH)	9	7.3	8.6	9.2	9.4	9.2	7.2	8.3	9.4	8.8	8	7.6
EC (1:5) (µS/cm)	212	75	33	102	212	305	42	130	565	578	557	121
Moisture Content (%)	1	6.3	4.4	4.8	5.1	3.2	2.1	4.4	7.4	6.7	5.2	2
Bicarbonate Extractable K (Colwell) (mg/kg)	100	222	160	187	162	133	195	<100	103	<100	116	440
Chloride (mg/kg)	10	30	20	<10	120	310	30	110	470	780	840	40
Copper (mg/kg)	1	1.5	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Iron (Fe) (mg/kg)	1	20	4.56	4.62	4.71	6.47	17.9	7.7	6.24	6.02	6.56	8.55
Manganese (mg/kg)	1	28.4	3.07	2.87	2.38	5.79	22	9.83	4.36	4.22	2.42	8.07
Zinc (mg/kg)	1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.74
Ammonia as N (mg/kg)	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Nitrite as N (Sol.) (mg/kg)	0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.1
Nitrate as N (Sol.) (mg/kg)	0.1	2.1	0.4	0.6	<0.1	0.1	1.6	0.8	0.2	<0.1	<0.1	25.5
Nitrite + Nitrate as N (Sol.) (mg/kg)	0.1	2.2	0.4	0.6	<0.1	0.1	1.8	0.8	0.2	<0.1	<0.1	25.6
Total Kjeldahl Nitrogen as N (mg/kg)	20	620	170	150	160	110	310	190	160	90	80	270
Total Nitrogen as N (mg/kg)	20	620	170	150	160	110	310	190	160	90	80	300
Total Phosphorus as P (mg/kg)	2	145	265	333	296	316	195	173	133	176	222	84
Bicarbonate Ext. P (Colwell) (mg/kg)	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Organic Matter (%)	0.5	1.8	<0.5	<0.5	<0.5	<0.5	0.9	0.6	<0.5	<0.5	<0.5	1
Total Organic Carbon (%)	0.5	1	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	0.6

Notes: < indicates less than the laboratory limit of reporting.

Table B4: Soil fertility anaysis results for Broadmeadow East

RGS Sample Number →		2020057_C1095	2020057_C1096	2020057_C1097	2020057_C1098	2020057_C1099	2020057_C1100	2020057_C1101	2020057_C1102	2020057_C1102_1
Sampling Date →		07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021	07/05/2021
ALS Laboratory ID →		EB2112584022	EB2112584023	EB2112584024	EB2112584025	EB2112584026	EB2112584027	EB2112584028	EB2112584029	EB2112584030
Composite Sample ID →		COAL (COAL	COAL (COAL							
Parameters	Limit of Reporting	SLT	SLT	SLT	SLT	SOIL	SLT	SLT	SLT	SLT
Exchangable Cations		All units meq/100g (except Exchangable Sodium Percentage (%))								
Exchangeable Calcium	0.2	3.2	2.2	1.6	1.7	1.8	0.4	0.2	0.2	0.2
Exchangeable Magnesium	0.2	4.3	3.3	2.6	3.2	1.2	1.1	0.8	0.8	0.9
Exchangeable Potassium	0.2	0.3	<0.2	<0.2	<0.2	0.2	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	0.2	1.9	2.8	2	2	<0.1	0.2	0.4	0.5	0.5
Cation Exchange Capacity	0.2	9.8	8.5	6.2	6.9	3.4	3.4	2.3	2.1	2.6
Exchangeable Sodium Percent	0.2	19.9	33	31.3	28.7	1.8	12.2	26.2	35.7	29.5
Calcium/Magnesium Ratio	0.2	0.8	0.6	0.6	0.5	1.5	0.4	0.2	0.2	0.2
Magnesium/Potassium Ratio	0.2	13.5	----	----	----	4.9	----	----	----	----
Analyte/Metals										
pH (1:5) (pH)	9	9.3	8.9	8.9	9	6.4	5.2	5	4.8	5
EC (1:5) (µS/cm)	212	249	129	232	318	15	28	46	110	67
Moisture Content (%)	1	6.3	4.2	4.4	4.2	4.5	3.3	1.8	2.3	2.2
Bicarbonate Extractable K (Colwell) (mg/kg)	100	154	140	118	165	164	<100	<100	<100	<100
Chloride (mg/kg)	10	60	110	280	410	10	20	50	130	90
Copper (mg/kg)	1	<1.00	<1.00	<1.00	<1.00	1.34	<1.00	<1.00	<1.00	<1.00
Iron (Fe) (mg/kg)	1	5.26	7.84	4.82	5.29	14.3	8.98	10.2	11.8	11
Manganese (mg/kg)	1	4.29	4.45	3.63	4.83	2.5	1.69	1.03	1.4	1.42
Zinc (mg/kg)	1	<1.00	1.33	<1.00	<1.00	16.4	1.43	<1.00	<1.00	<1.00
Ammonia as N (mg/kg)	20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Nitrite as N (Sol.) (mg/kg)	0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
Nitrate as N (Sol.) (mg/kg)	0.1	0.6	0.8	0.3	0.7	1.3	<0.1	<0.1	<0.1	<0.1
Nitrite + Nitrate as N (Sol.) (mg/kg)	0.1	0.6	0.8	0.3	0.7	1.4	<0.1	<0.1	<0.1	<0.1
Total Kjeldahl Nitrogen as N (mg/kg)	20	130	160	80	200	300	50	<20	40	30
Total Nitrogen as N (mg/kg)	20	130	160	80	200	300	50	<20	40	30
Total Phosphorus as P (mg/kg)	2	80	129	81	114	98	109	49	60	58
Bicarbonate Ext. P (Colwell) (mg/kg)	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Organic Matter (%)	0.5	<0.5	<0.5	<0.5	<0.5	1.1	0.7	<0.5	0.5	<0.5
Total Organic Carbon (%)	0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5

Notes: < indicates less than the laboratory limit of reporting.

9.3 Attachment C: KLC Methods and Results

KLC Program: Broadmeadow East

Kinetic leach column (KLC) tests can be used to provide information on the reaction kinetics of mine waste materials. The major objectives of kinetics tests are to:

- provide time-dependent data on the kinetics and rate of acid generation and acid neutralising reactions under laboratory controlled (or onsite conditions)
- investigate metal release and drainage/seepage quality
- examine the impact of mine materials on the chemistry of water moving through these materials over time
- assess treatment options such as addition of alkaline materials

Material types

Mine material used in the columns includes reject coal, coal roof, and coal floor, based on lithology logs provided by M Resources (**Table 9-4**)

Table 9-4. KLC program summary

KLC column	Material	KLC method	Start date	End date	Water added each leach event (mm)
KLC # 1	Coal roof (100%)	Saturated	30/04/2021	20/05/2021	938
KLC # 2	Coal (100%)	Free leach	30/04/2021	03/03/2022	1400
KLC # 3	Coal floor (100%)	Saturated	30/04/2021	20/05/2021	611
KLC # 4	Coal roof (100%)	Free leach	30/04/2021	03/03/2022	1400
KLC # 5	Coal (100%)	Saturated	30/04/2021	20/05/2021	875
KLC # 6	Coal floor (100%)	Free leach	30/04/2021	03/03/2022	1400

9.3.1 Method

Kinetic leach column (KLC) testing involves placing a material sample in a column then adding water to the top of the column, causing the water to leach through the sample. The resultant leachate is then sent to a laboratory to measure a full suite of chemical parameters (e.g., pH, EC, salts, and dissolved metal(loids)). The kinetic tests allow an assessment of the acid forming characteristics and indicate the rate of acid generation, over what period it will occur, and what management controls may be required.

To achieve accurate and applicable results it is important that the selected column design and method are appropriate for the material characteristics and site conditions.

There are two kinetic leach testing methods that are readily used for kinetic leach cell testing. These include the:

USA ASTM D5744-18 Standard Test Method for Laboratory Weathering of Solid Materials Using a Humidity Cell

- Cells having suggested dimensions of 10.2-cm (4.0-in.) inside diameter (ID) by 20.3-cm (8.0-in.) height can be used to accommodate coarse solid material samples that have been either screened or crushed to 100 % passing 6.3 mm (1⁄4in.).
- Cells with suggested dimensions of 20.3-cm (8.0-in.) ID by 10.2-cm (4.0-in.) height can be used to accommodate solid material samples that pass a 150-µm (100-mesh) screen (examples would be processed mill tailings or fly ash).

- This test method covers a procedure that accelerates the natural weathering rate of a solid material sample so that diagnostic weathering products can be produced, collected, and quantified.
- This test method calls for the weekly leaching of a 1000-g solid material sample, with water of a specified purity, and the collection and chemical characterization of the resulting leachate over a minimum period of 20 weeks.
- The test procedure calls for weekly cycles comprised of three days of dry air (less than 10 % relative humidity) and three days of water-saturated air (approximately 95 % relative humidity) pumped up through the sample, followed by a leach with water on Day 7.
- A test duration of 20 weeks is recommended, but in many instances these tests need to continue for 52 weeks or more.
- This test method is not intended to simulate site-specific leaching conditions. It has not been demonstrated to simulate actual disposal site leaching conditions.

AMIRA Project P387A Prediction & Kinetic Control of Acid Mine Drainage Free Draining Leach Column Test Procedure

- The free draining leach column test utilises a plastic Buchner Funnel with an internal dimension of 175 mm in diameter and 100 mm high, giving a capacity of about 2.5 litres.
- The free draining leach column operation is designed to achieve a weekly wet-dry cycle and a monthly leaching cycle.
- Typically, this size funnel will hold about 2 to 2.5 kg of crushed rock, tailings or sediment.
- Heat lamps are used to ensure drying of the sample between test solution applications.
- For the conventional Buchner Funnel set-up mine rock samples are usually crushed to –4 mm to allow sufficient material surface exposure.
- A water to rock ratio of 1:1 or 0.5 to 1 is used.

There are also references to other KLC methods in the literature that include the following:

- Advanced Customisable Leach Columns (ACLC) – A New Kinetic Testing Method to Predict AMD risks by Simulating Site-specific Conditions. Proceedings IMWA 2016.
- Percolation test PrEN 14405
- pH Dependence leaching test ANC PrEN 14429 pH stat PrEN 1499
- Tank leaching test NEN7345
- Method 1314 – Percolation Column
- ASTM D4874 - 95(2014) Standard Test Method for Leaching Solid Material in a Column Apparatus

Reasons for using the RGS large free draining KLC test method

The decision to use larger kinetic leach columns rather than AMIRA KLC or ASTM HCT test methods is based on 15 years of experience in this field. Some of the key points that have driven RGS to use the large free draining KLC test method include the following:

- The AMIRA HCT test method is a USA method developed to accelerate weathering rates, rather than to obtain data that may be indicative of behaviour under field conditions.
- The AMIRA KLC method is prone to the following problems:
  - Maintains surface temperature of > 30℃
  - Like the ASTM method the column size is limited to < 2.5 L capacity and this reduce the sample mass that can be placed into the column and tested, reducing sample representation.

- In cases where the sample contains a high proportion of fine material dominated by clay, the samples can shrink during heating, and enable preferential flow of water down the sides of the sample i.e. most of the sample is not leached with water.
- The application of water by hand using a small bottle is subjective.
- The AMIRA Free Draining Column Test Procedures recommends weekly wetting (not leaching) of the sample and monthly leaching to collect a sample.
- Larger columns avoid this by incorporating a greater range of particle sizes, creating more flow paths through the material in the column. A larger range of particle sizes also makes the results derived from columns more accurate when scaling-up to larger volumes of materials (Maest et al., 2005).

RGS KLC method (Broadmeadow program)

The specification for the RGS KLC method (**Figure 9-1**) includes the following:

- Polycarbonate column with 15 cm diameter and 30 cm height and a volume of 13.5 L.
- A tap is fitted at the base of the column.
- Full static analysis is completed on a split of the KLC sample.
- Physical testing including particle size distribution is completed on a split of the sample.
- Rock / spoil is crushed to pass 20 mm sieve.
- Material is sieved to < 20 mm, and 3 kg of each sample is placed into the column.
- Pore volume is recorded for each sample by saturating the material with DI water.

Free leach columns:

- The free leach method uses open top columns.
- For the free leach columns, 1.4 L (RGS standard for waste rock KLC's) of deionised (DI) laboratory grade water was used once a month for each leach event.
- The leach cycle included turning off the taps at the bottom of the KLC before adding water, adding the water to the column over 10 minutes.
- The water is left to percolate through the sample and is then retained in the sample for 24 hours.
- After 24 hours the tap is opened, and the water is collected. The volume, pH, and EC are measured at 24 hours.
- The volume of water utilised was sufficient to recover a sample for the required analyses undertaken by ALS.
- Leachate samples were then sent to ALS for pH, EC, acidity, alkalinity, major ions, and metal(loids).
- After leaching, the samples are left without water to expose the samples to drying conditions and simulate rain events in the field.

Saturated columns:

- The saturated method uses enclosed columns.
- For the saturated columns, the pore volume calculated in the set-up of the tests of DI water was used once a week for each leach event to saturate the material (**Table 9-4**).
- The leach cycle included turning off the taps at the bottom of the KLC before adding water, adding the water to the column over 10 minutes.
- The water is left to percolate through and saturate the sample and is then retained in the sample for one week.
- After one week the tap is opened and the pore water volume is collected. The volume, pH, and EC are measured at 24 hours.

- The volume of water utilised was sufficient to recover a sample for the required analyses undertaken by ALS.
- Leachate samples were then sent to ALS for pH, EC, acidity, alkalinity, major ions, and metal(loids).
- After leaching, the tap is turned back off and the column is refilled with DI water.

9.3.2 Analytical program

Analyses initially undertaken on the materials and analyses conducted on leachates collected from the columns during the KLC program are shown in **Table 4-3**.

The ALS laboratory certificates of analysis for the KLC test program are in **Section 9.4**.

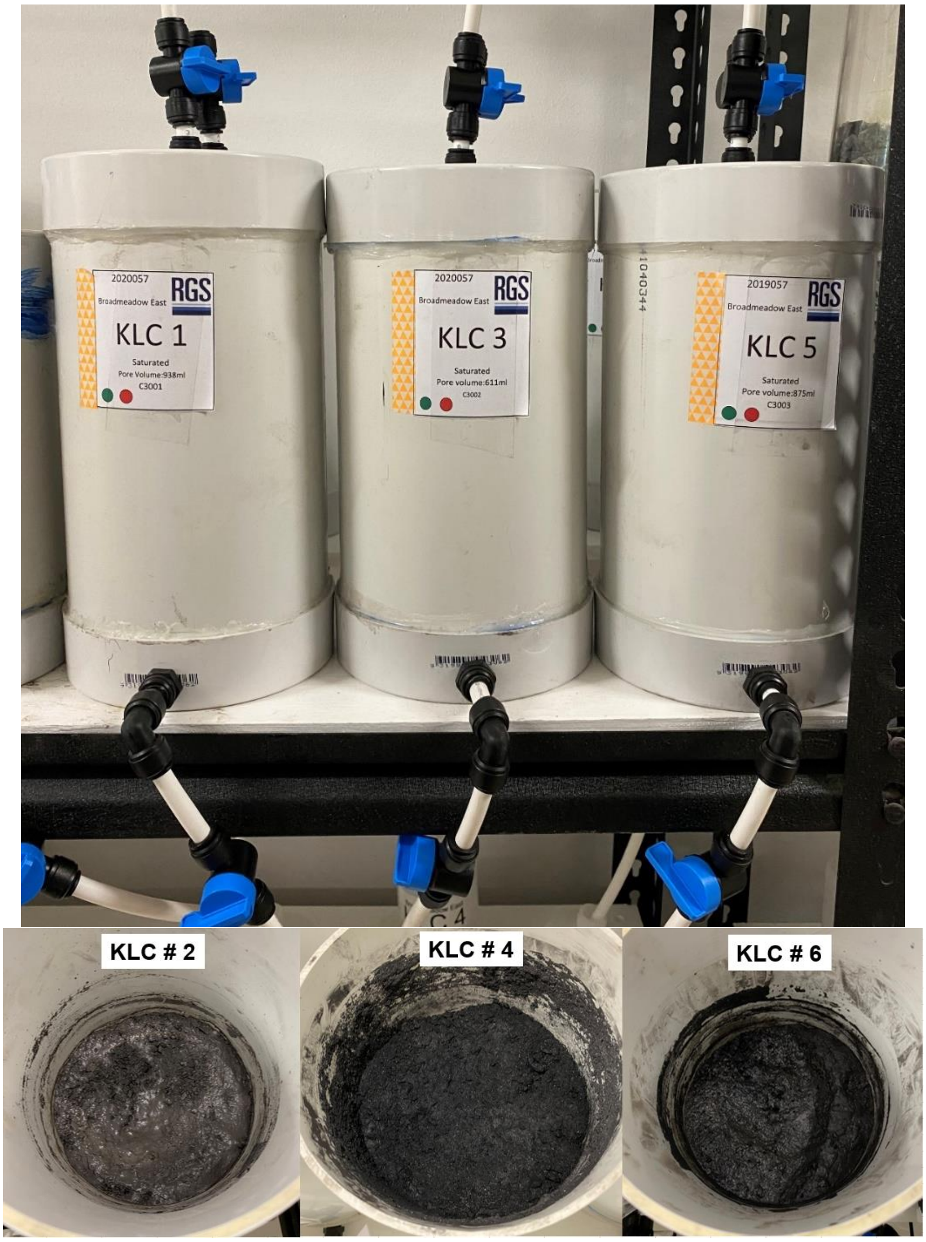
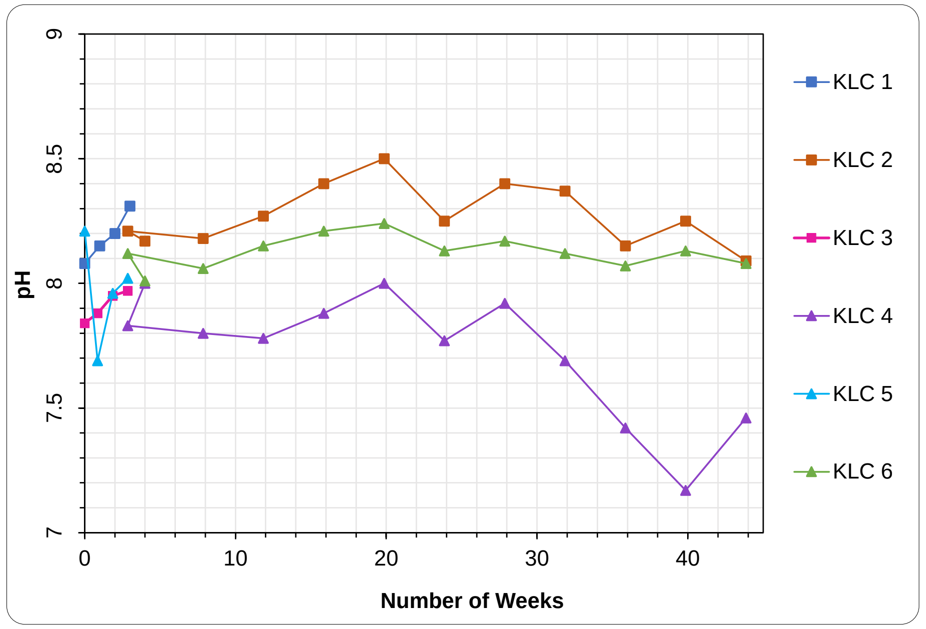
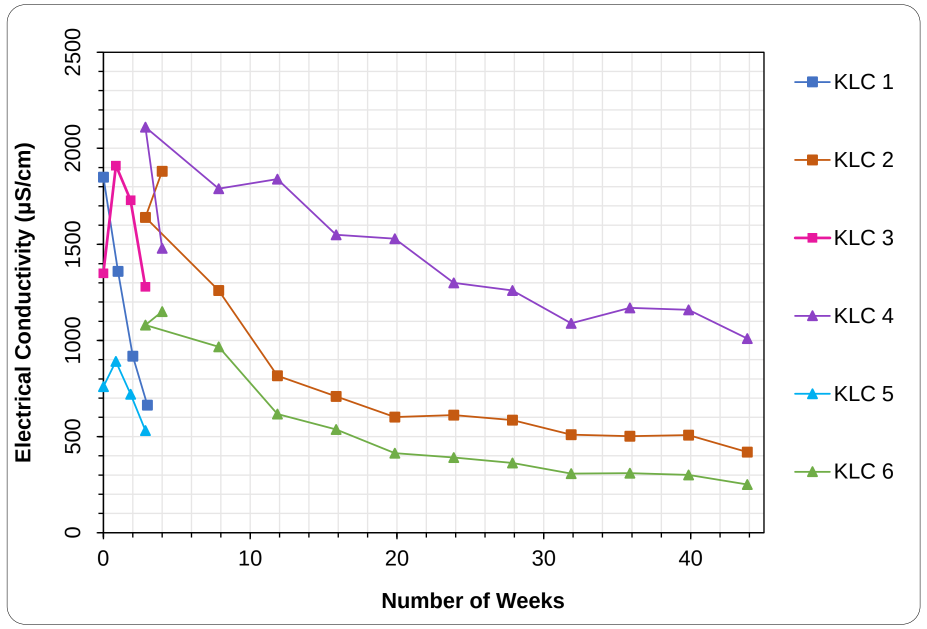


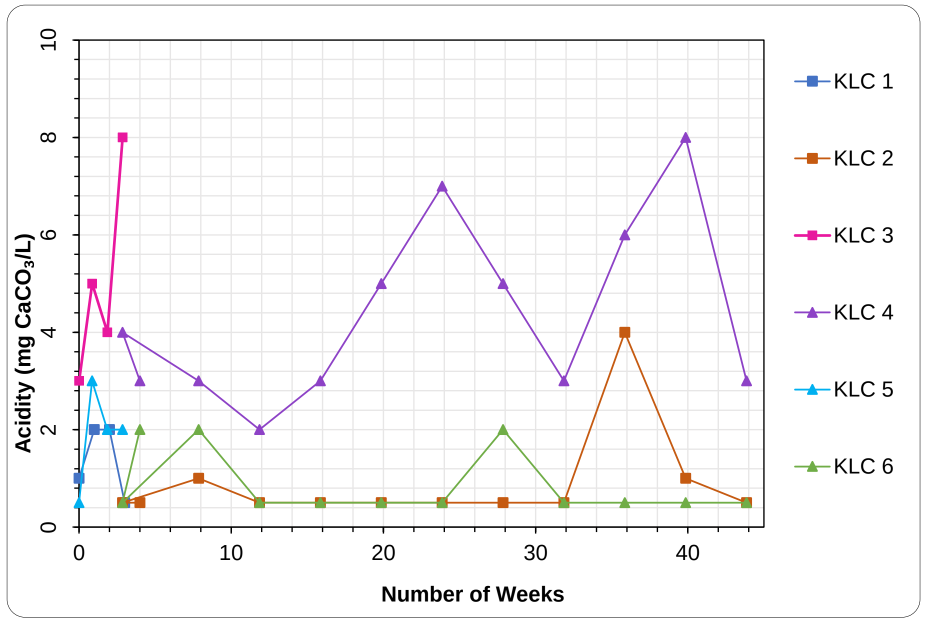
Figure 9-1. Broadmeadow East columns

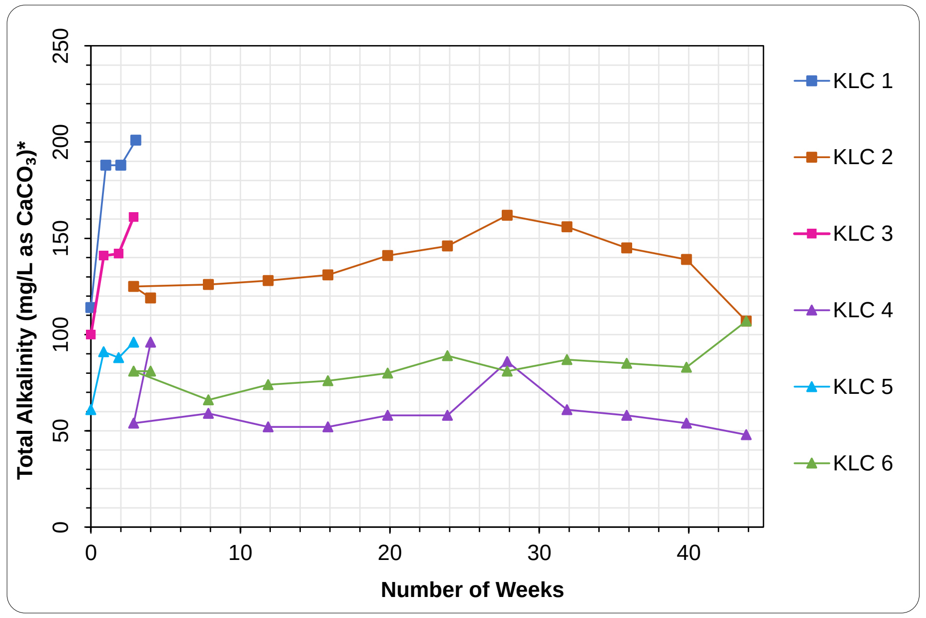


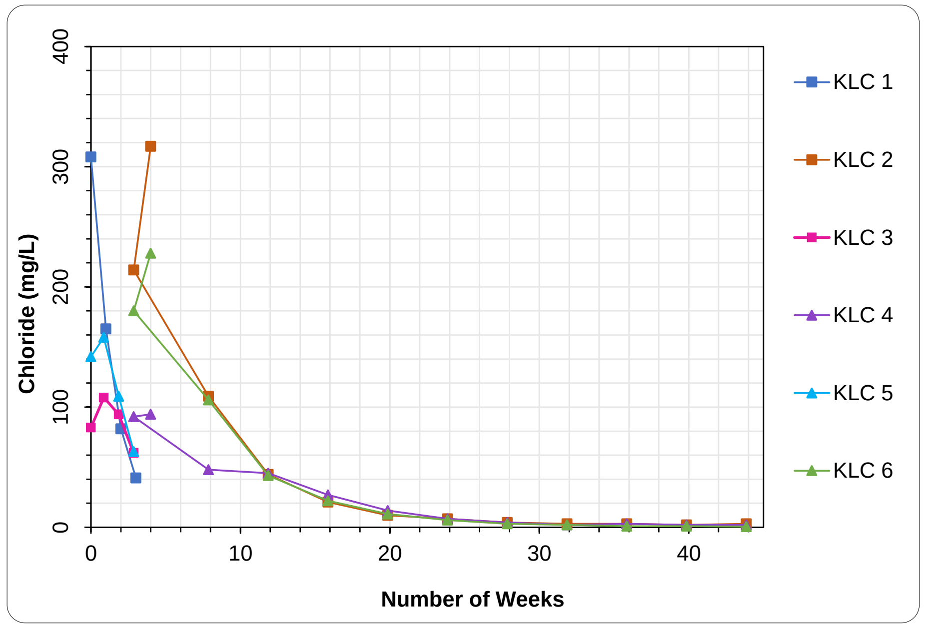


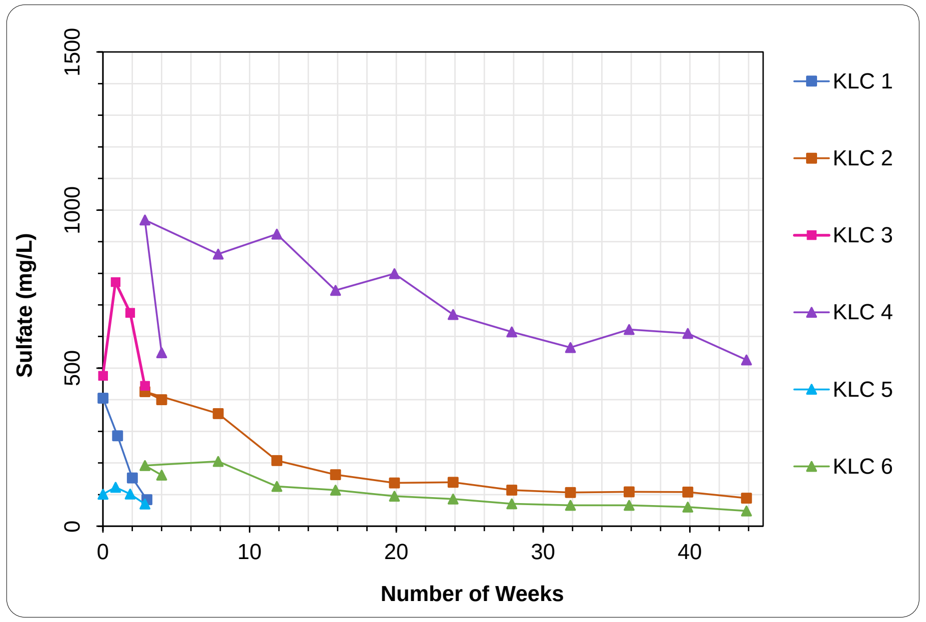
LEGEND:

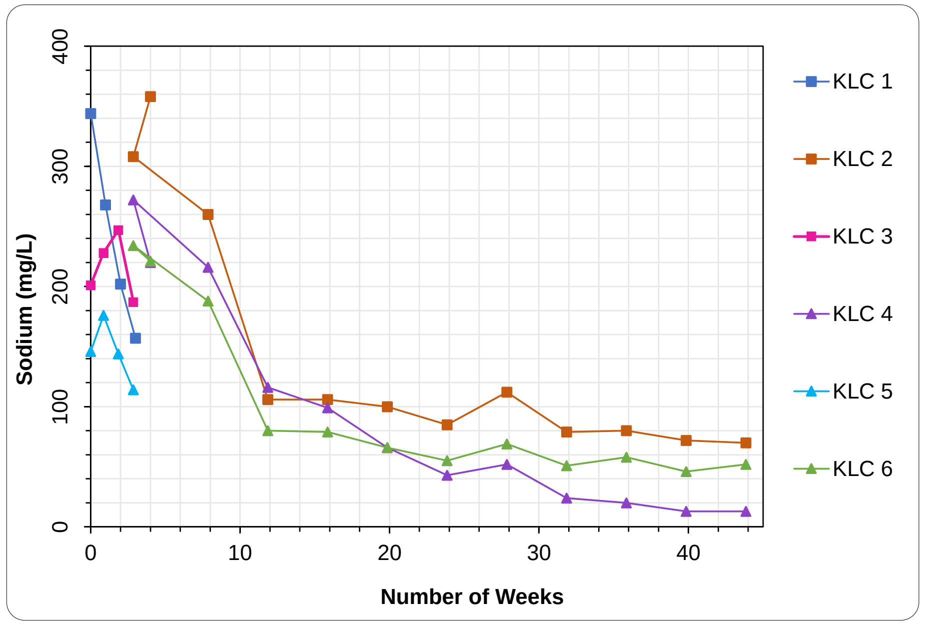
KLC 1 Roof (Saturated)
KLC 2 Roof (Free Leach)
KLC 3 Coal (Saturated)
KLC 4 Coal (Free Leach)
KLC 5 Floor (Saturated)
KLC 6 Floor (Free Leach)

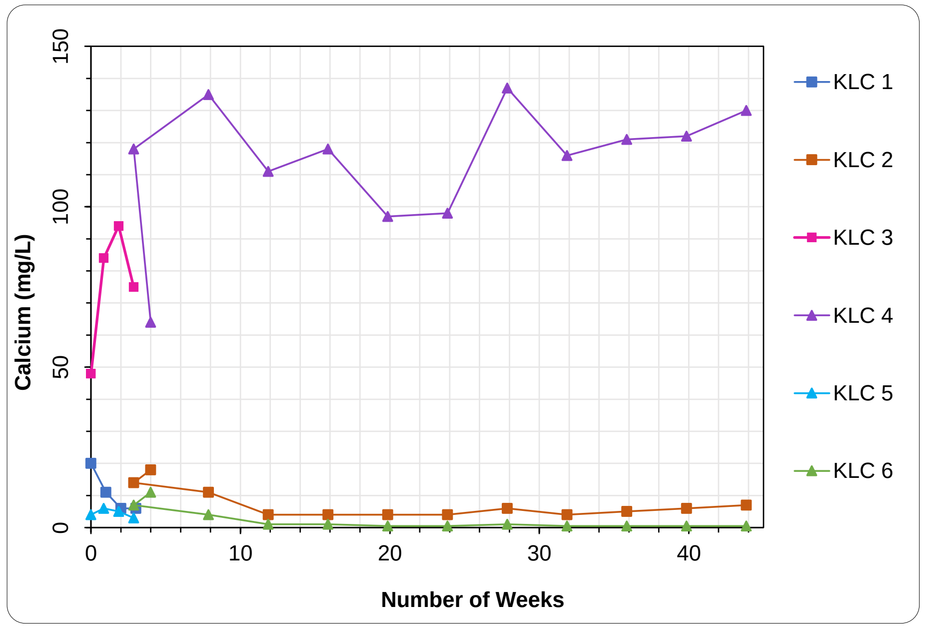


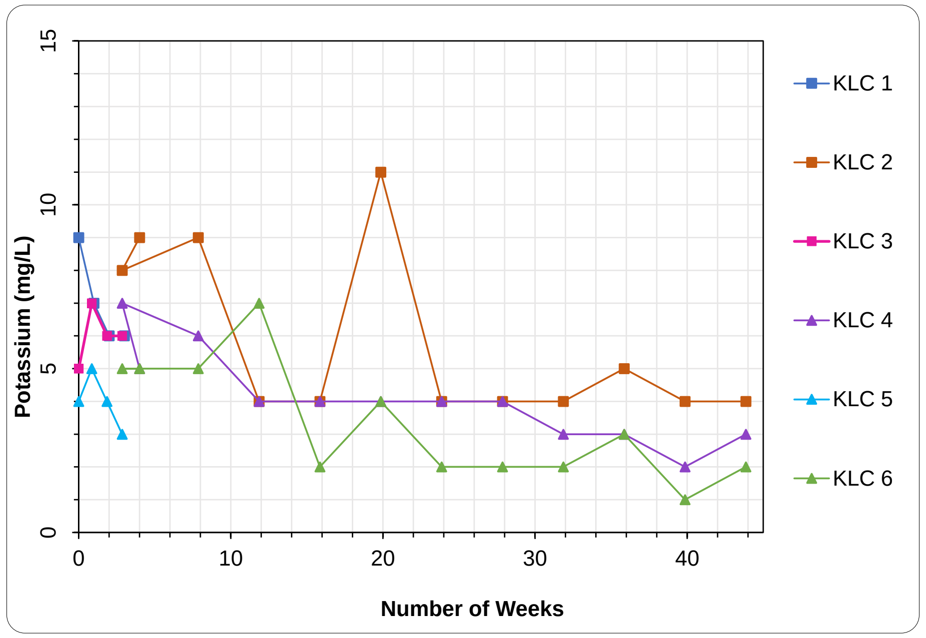


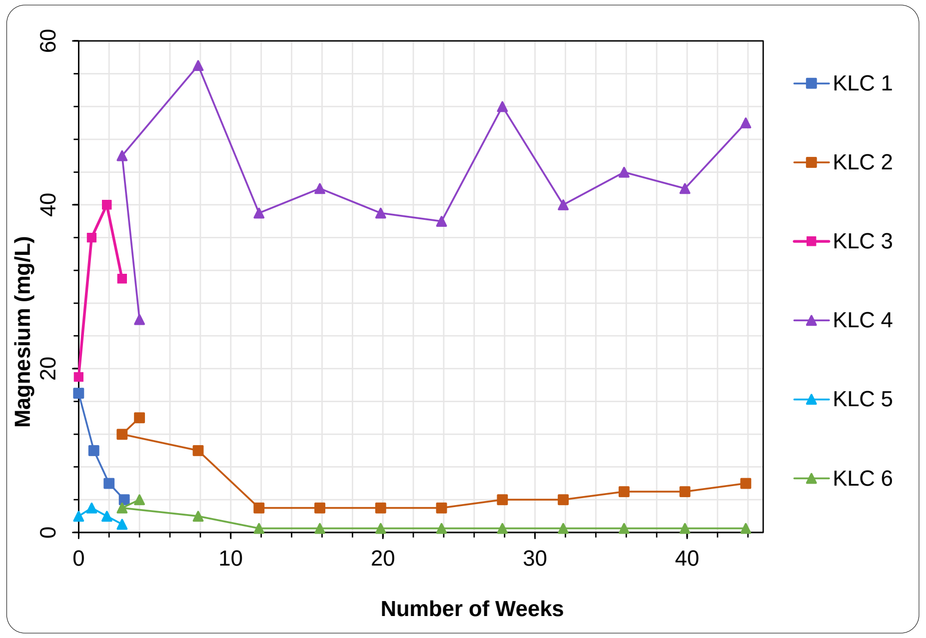






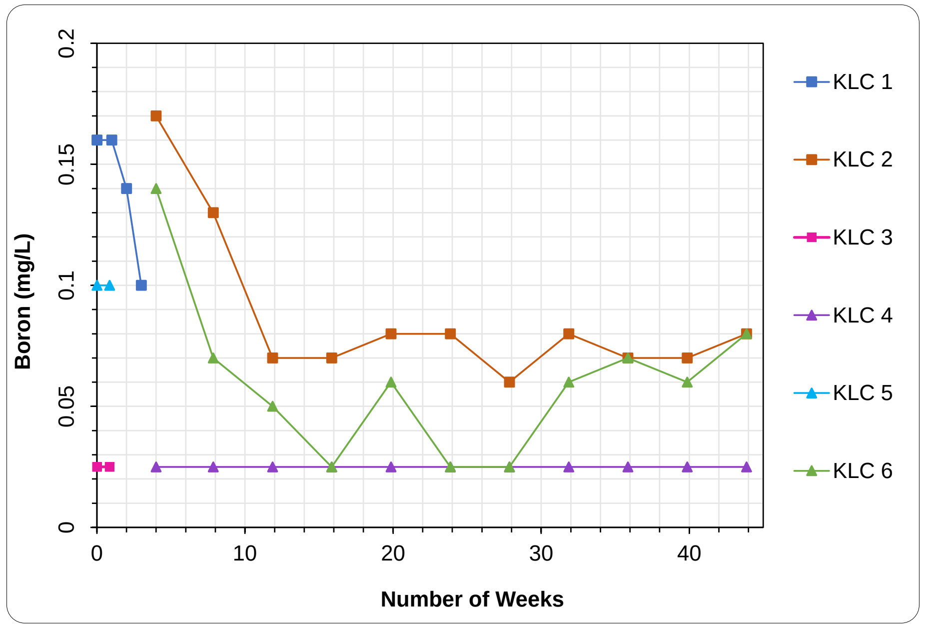


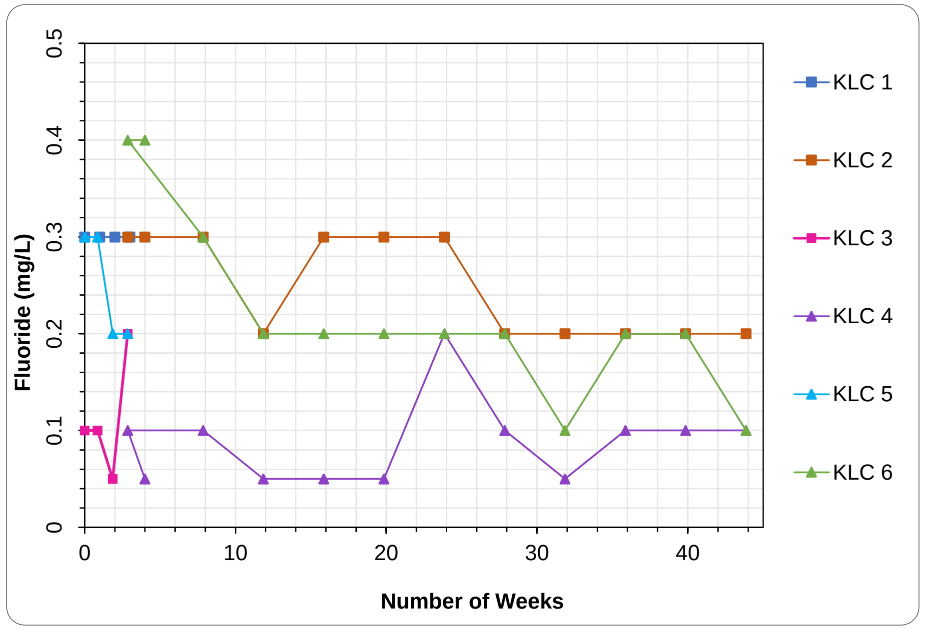


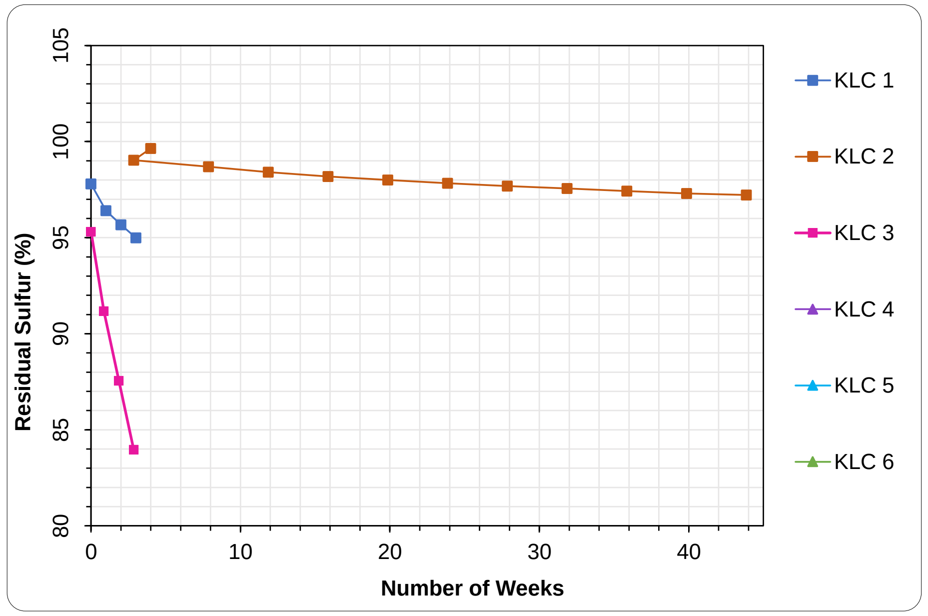


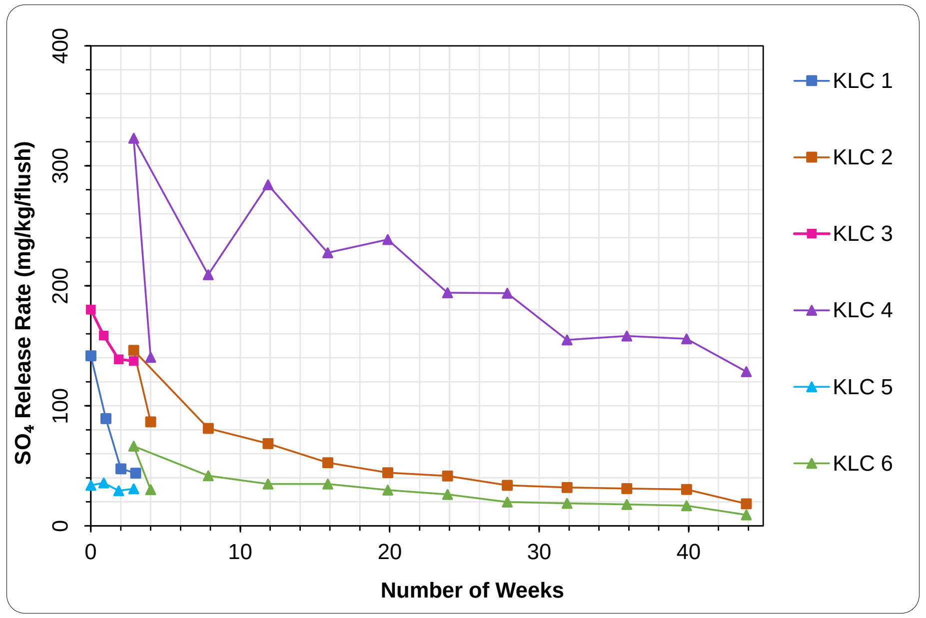
LEGEND:

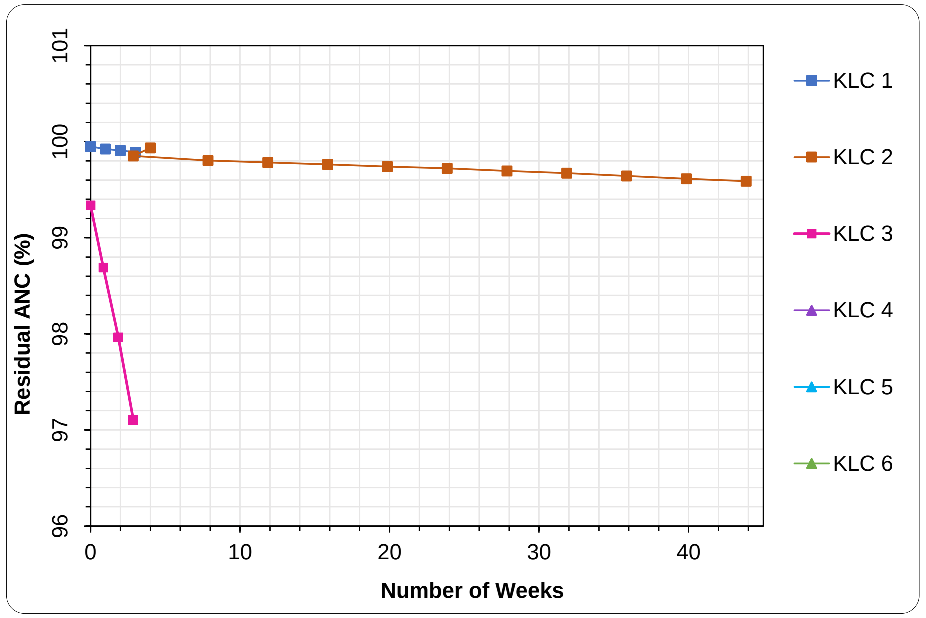
KLC 1 Roof (Saturated)
KLC 2 Roof (Free Leach)
KLC 3 Coal (Saturated)
KLC 4 Coal (Free Leach)
KLC 5 Floor (Saturated)
KLC 6 Floor (Free Leach)

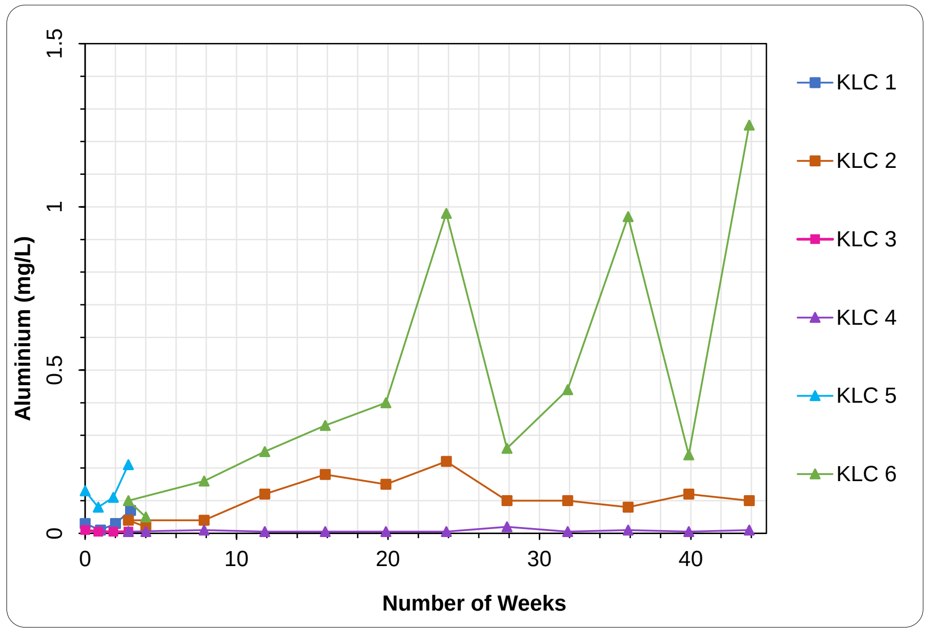


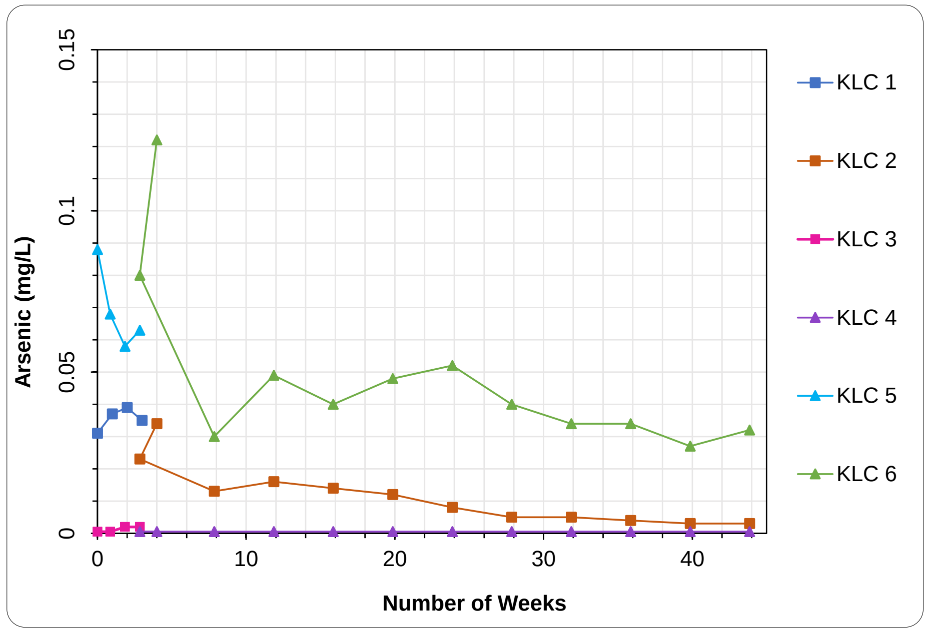


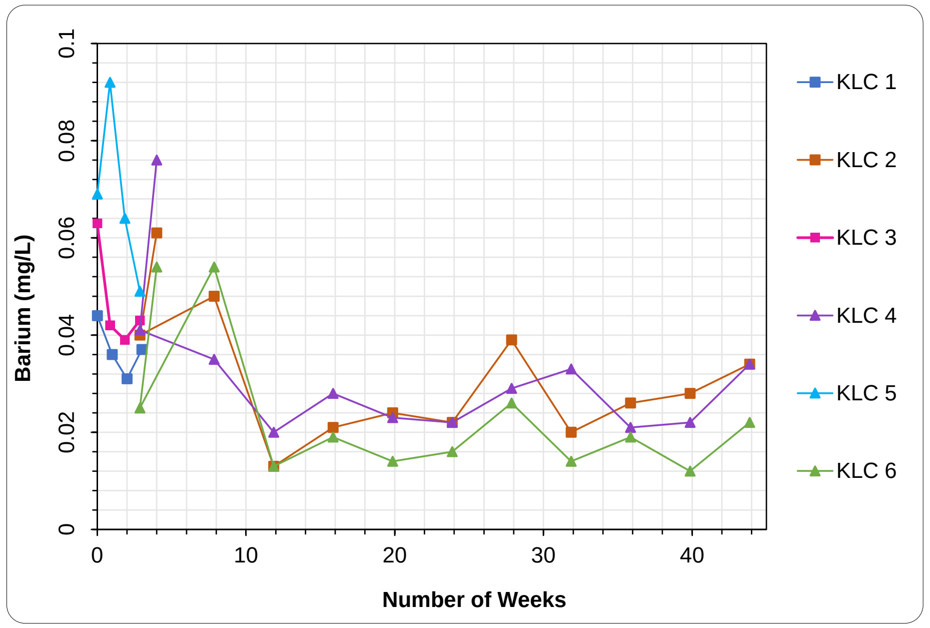


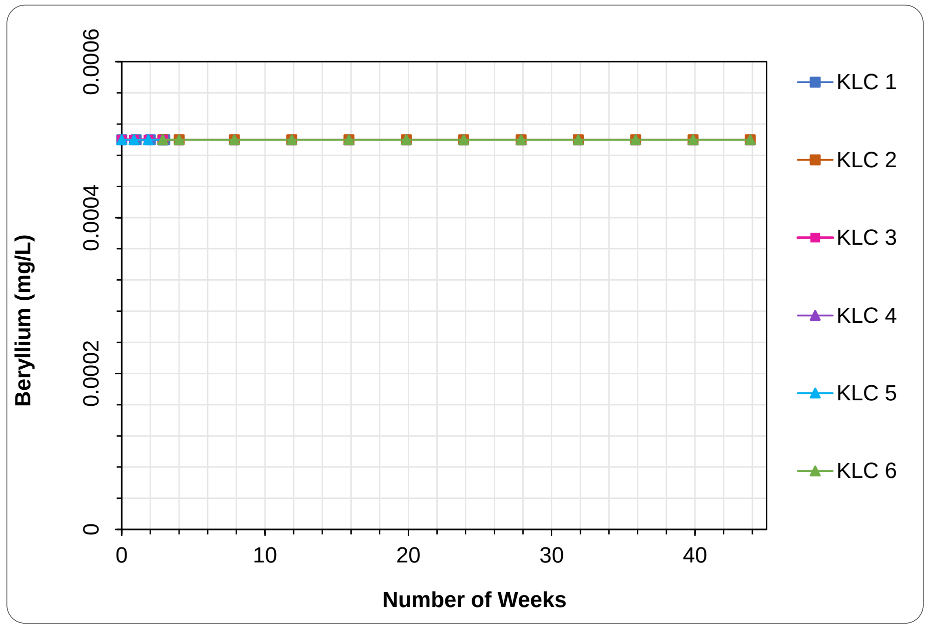


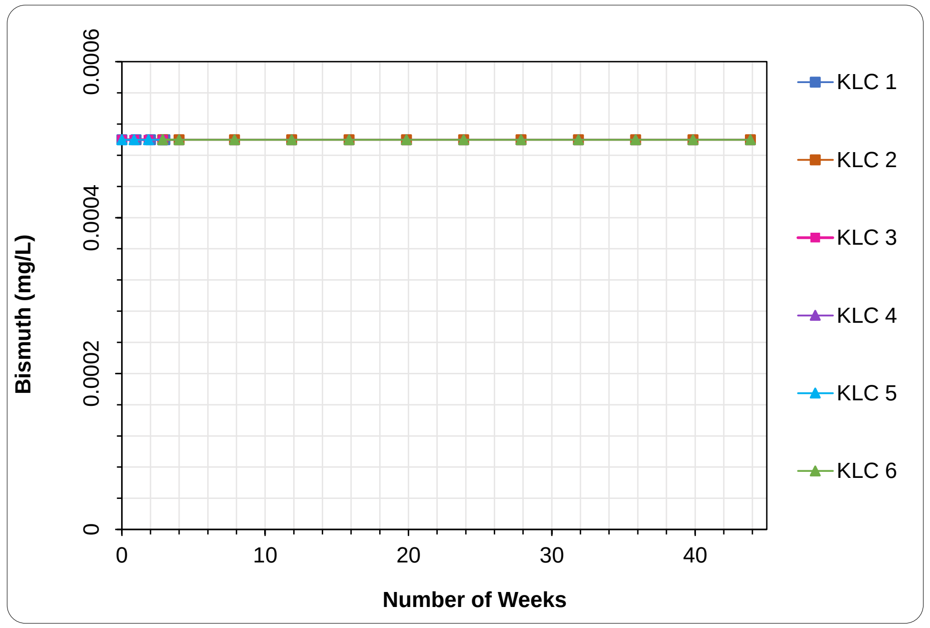


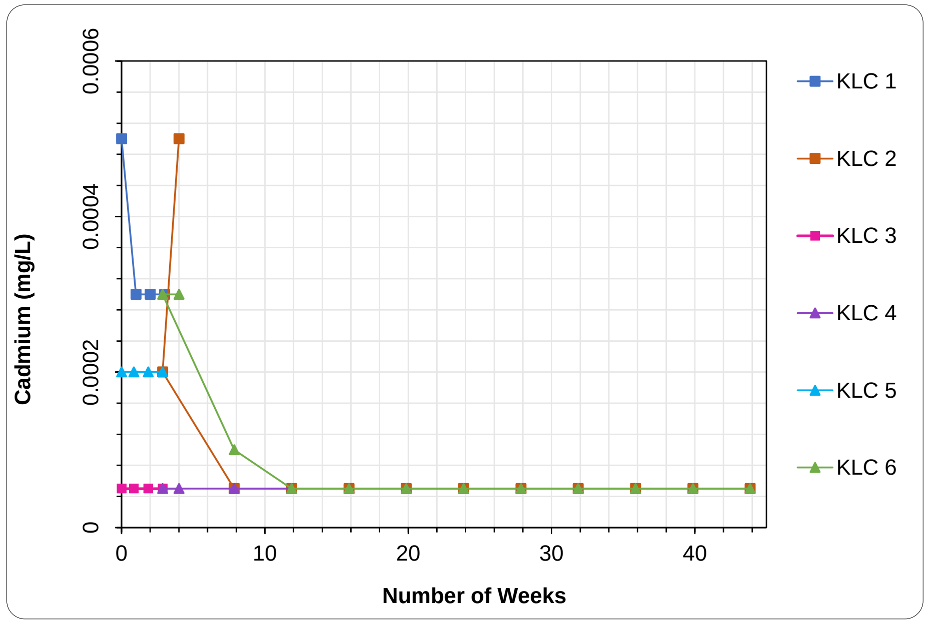

Aluminium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

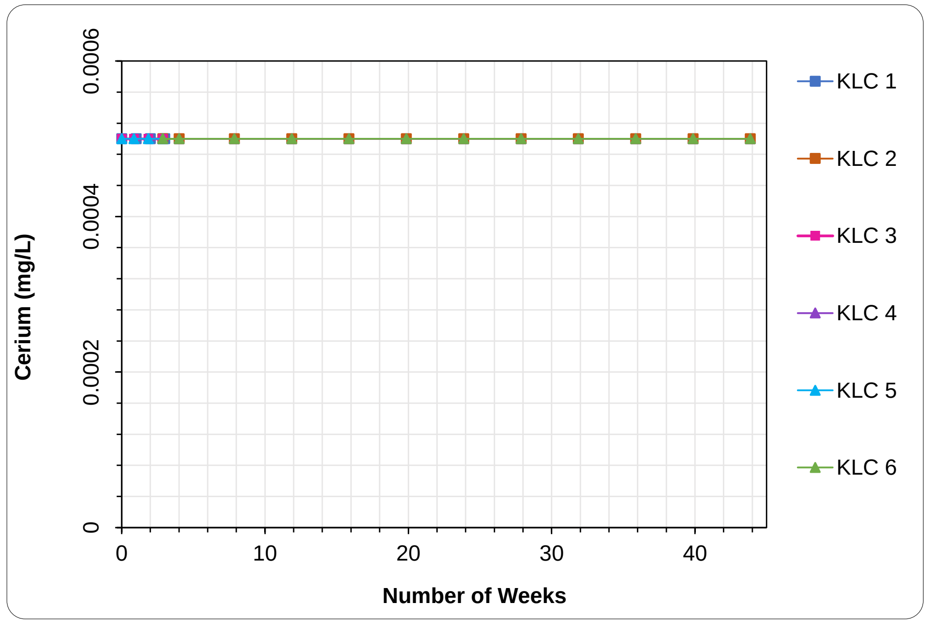

Arsenic (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

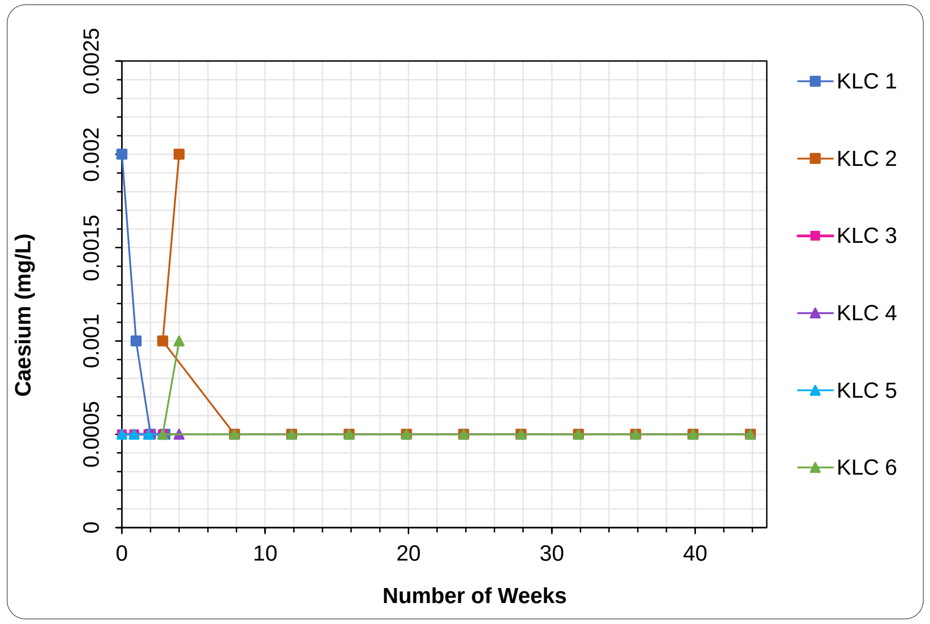

Barium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

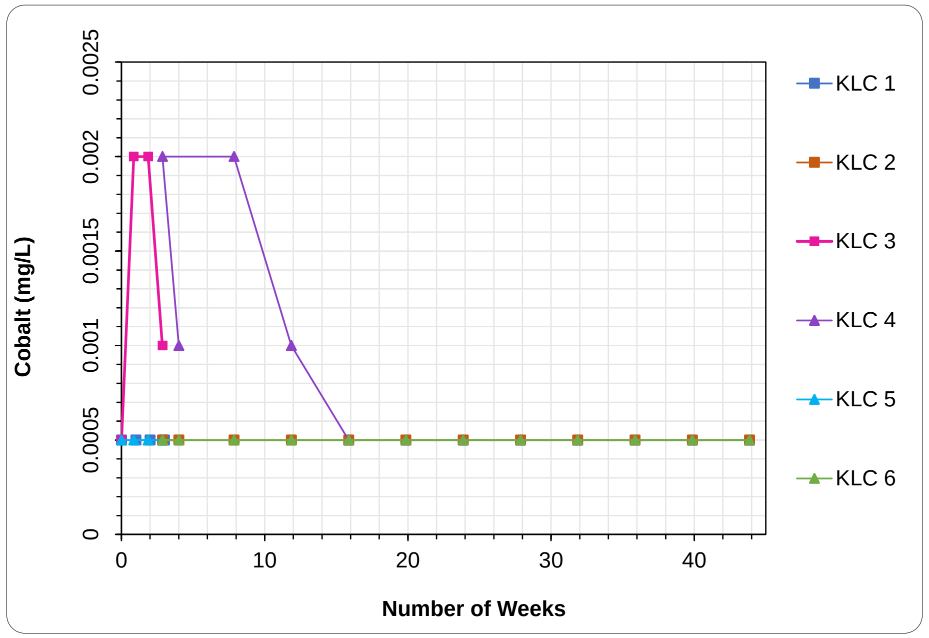

Beryllium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

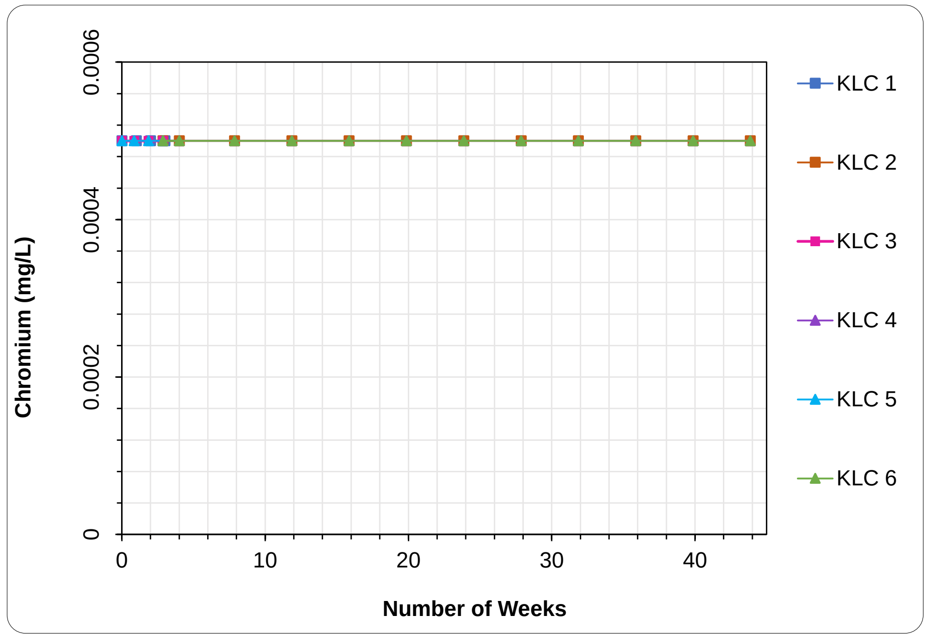

Bismuth (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6


Cadmium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6


Cerium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

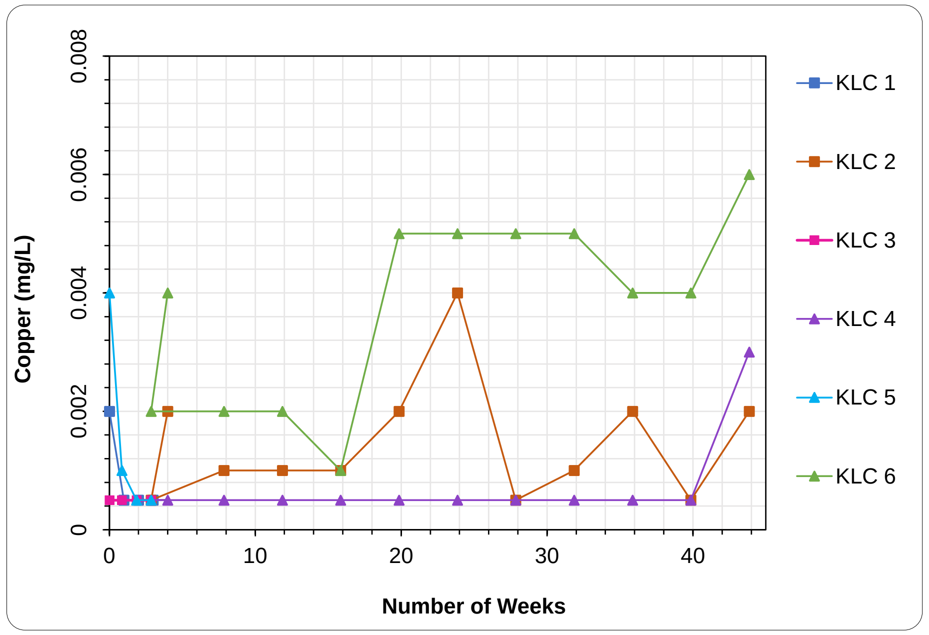

Caesium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

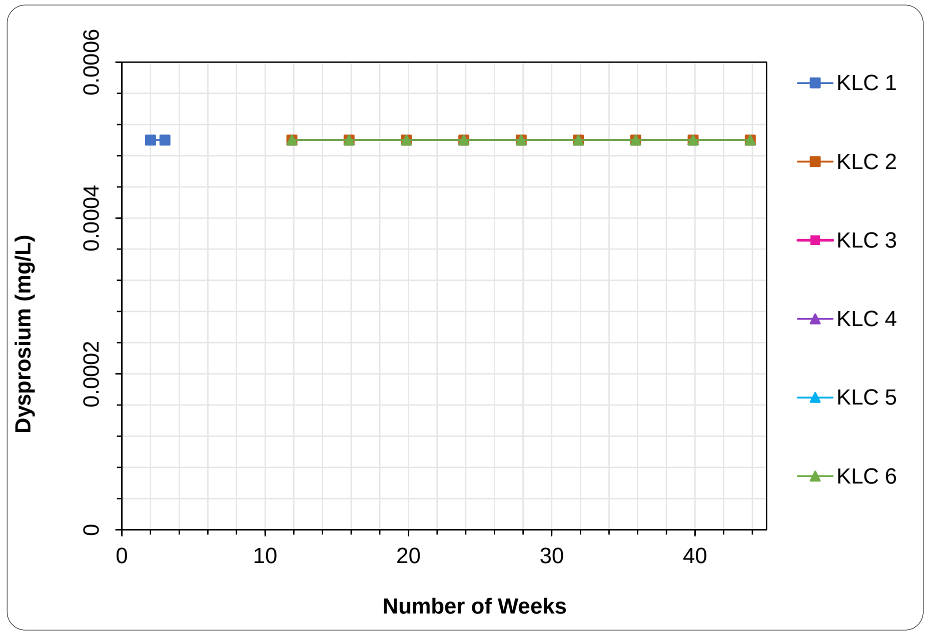


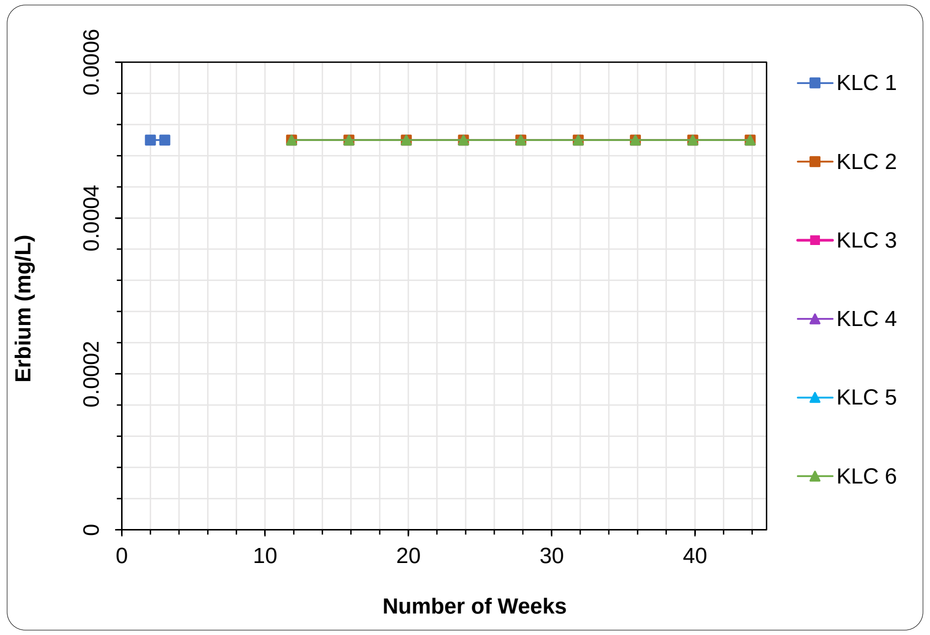


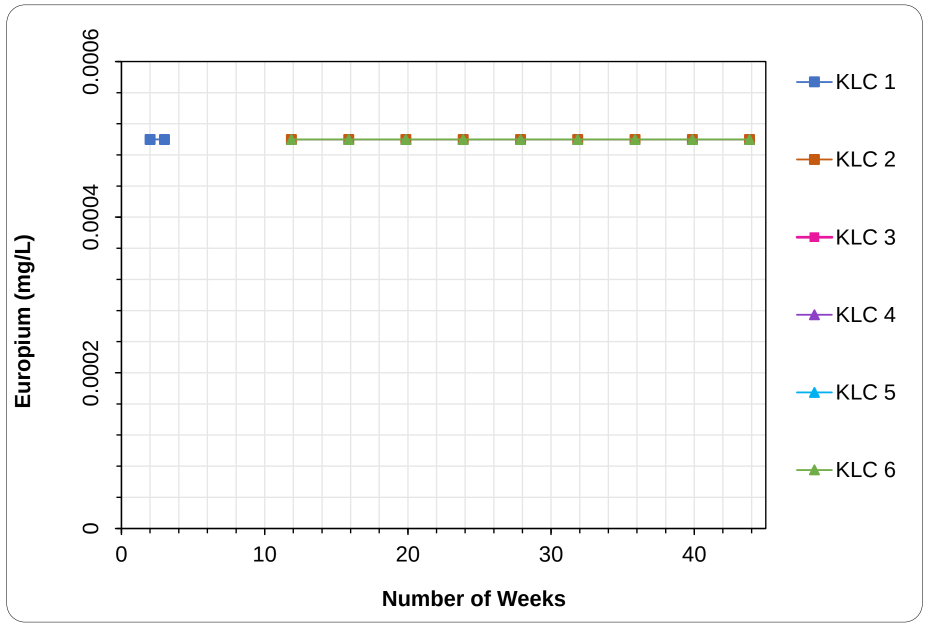
LEGEND:

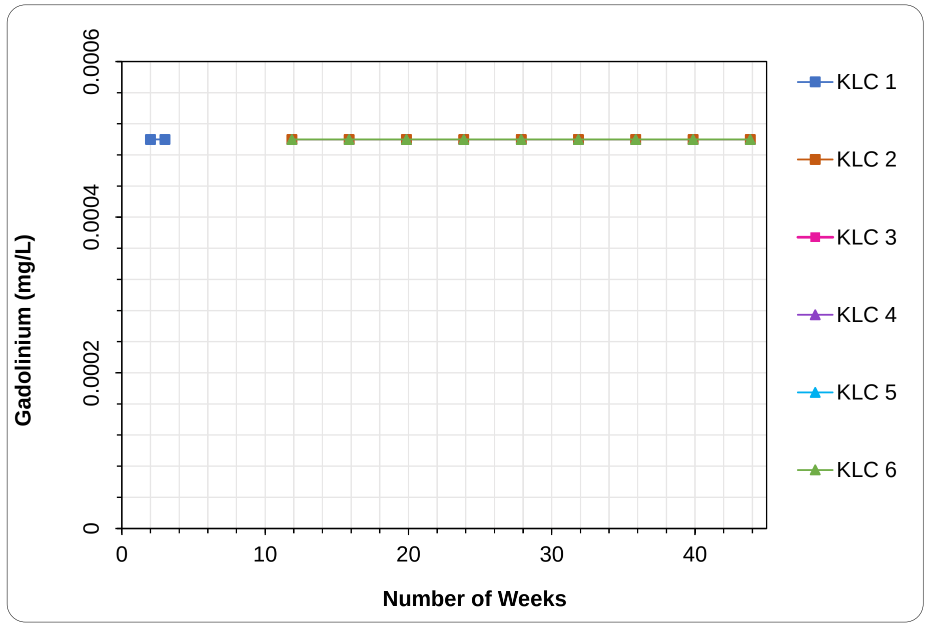
KLC 1 Roof (Saturated)
KLC 2 Roof (Free Leach)
KLC 3 Coal (Saturated)
KLC 4 Coal (Free Leach)
KLC 5 Floor (Saturated)
KLC 6 Floor (Free Leach)

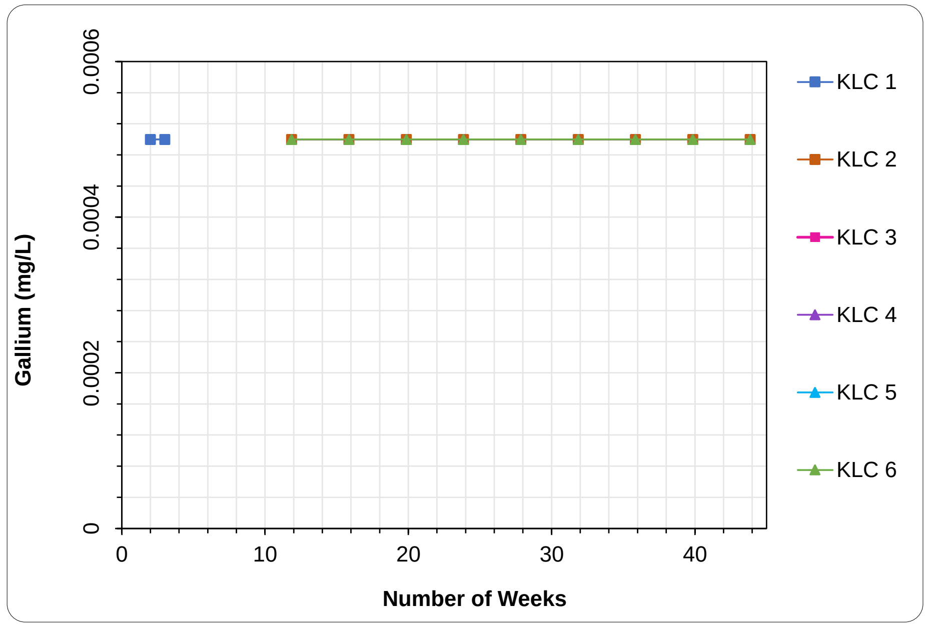


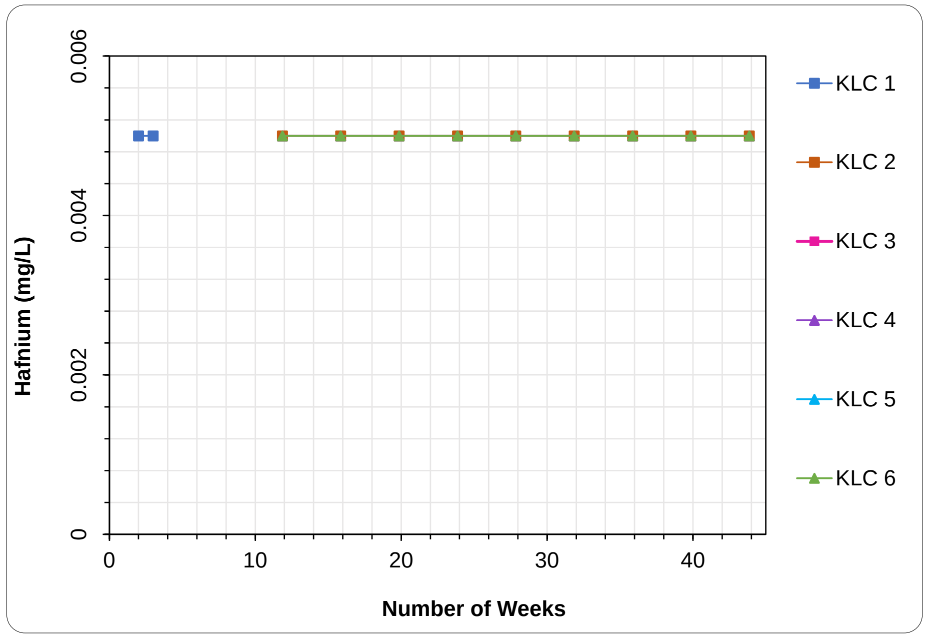


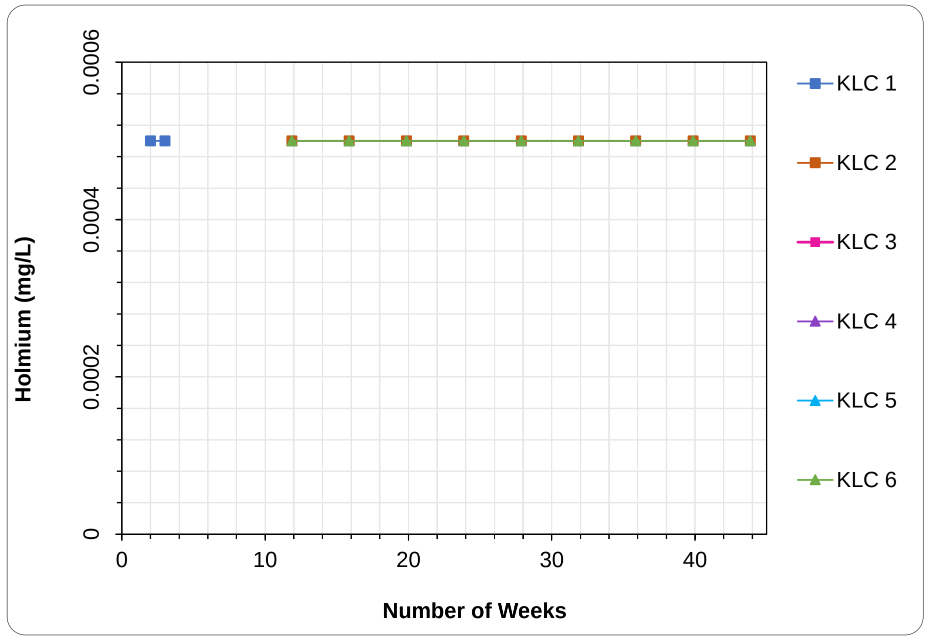




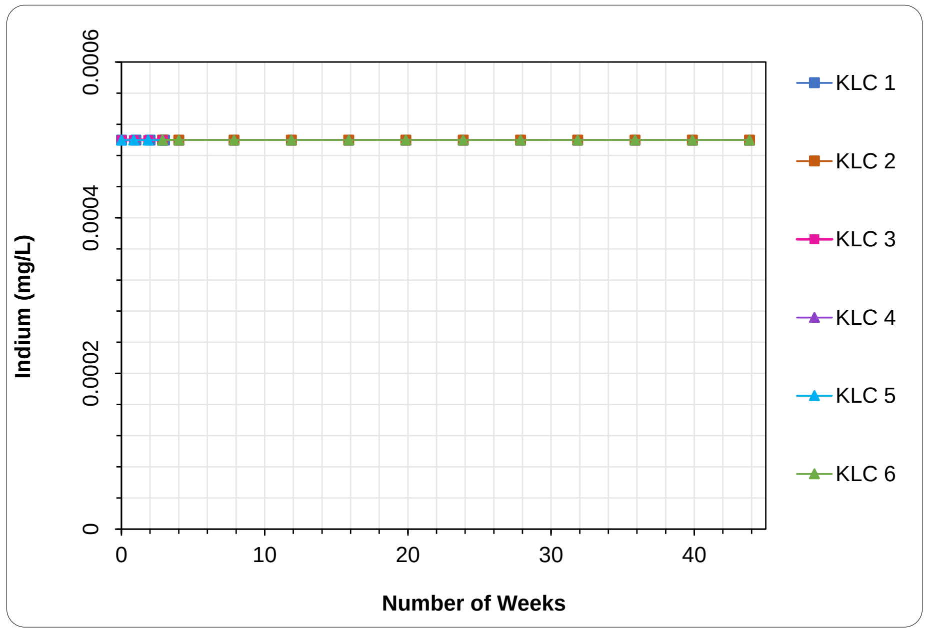


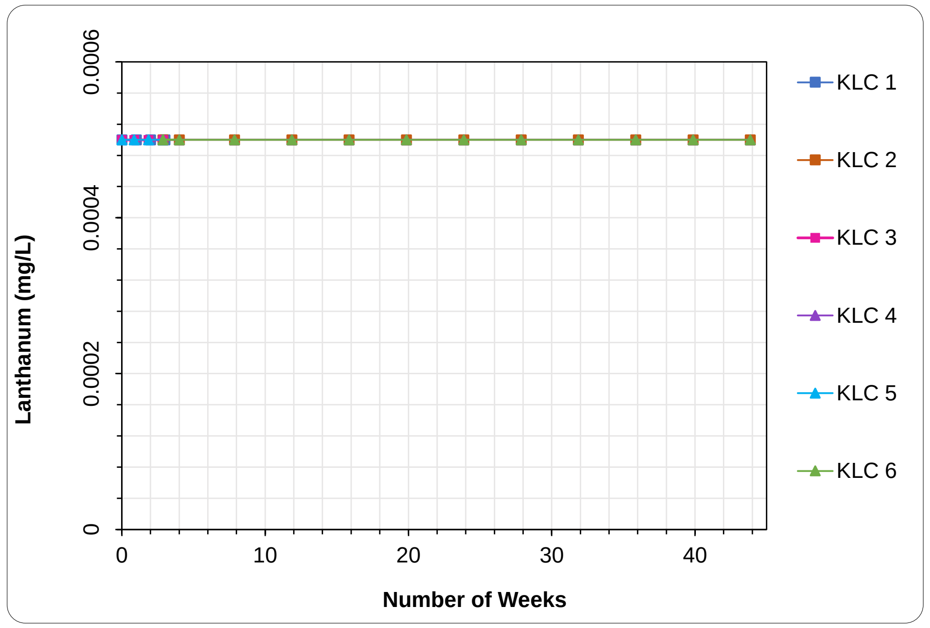


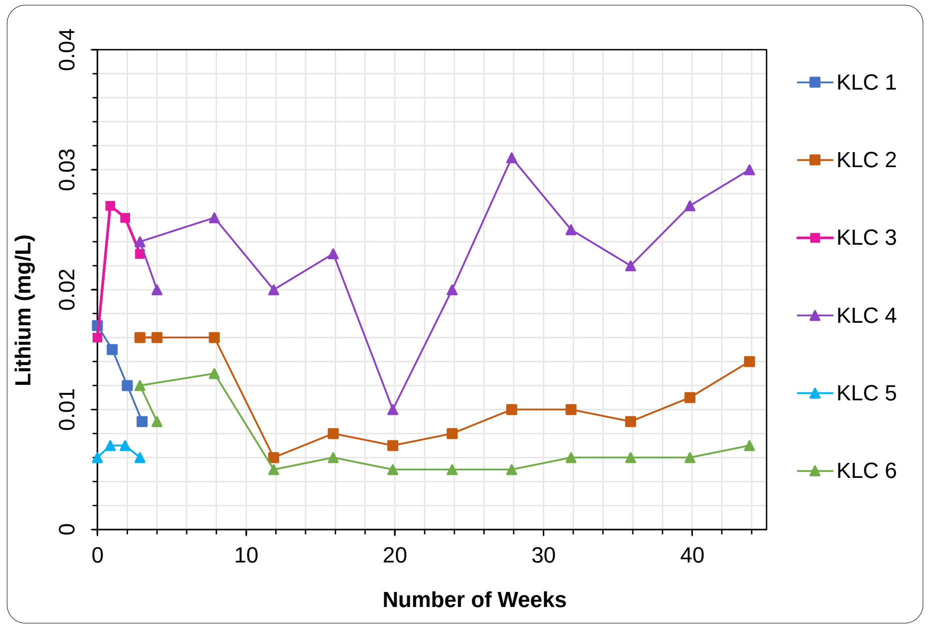

Hafnium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

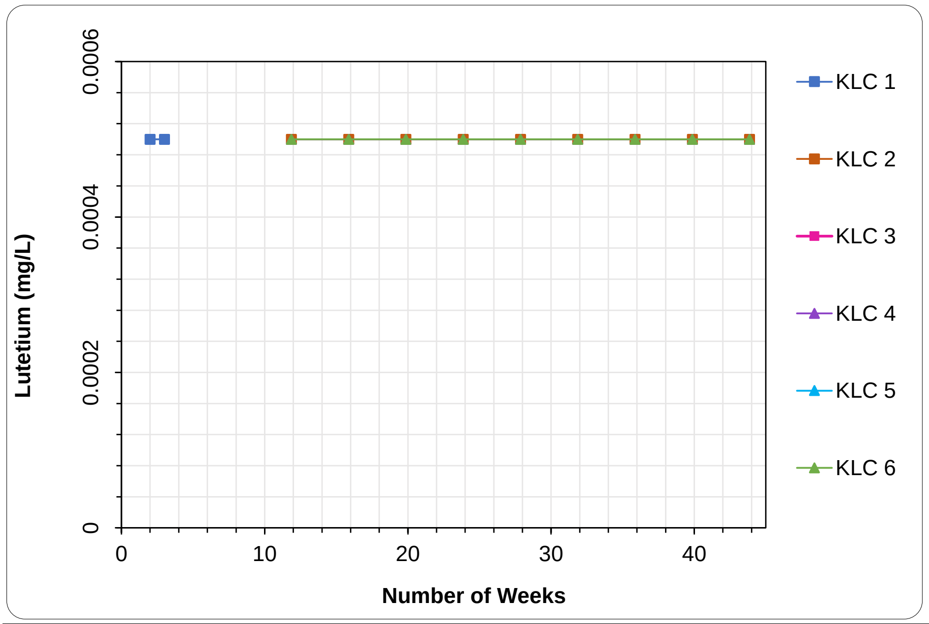

Holmium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

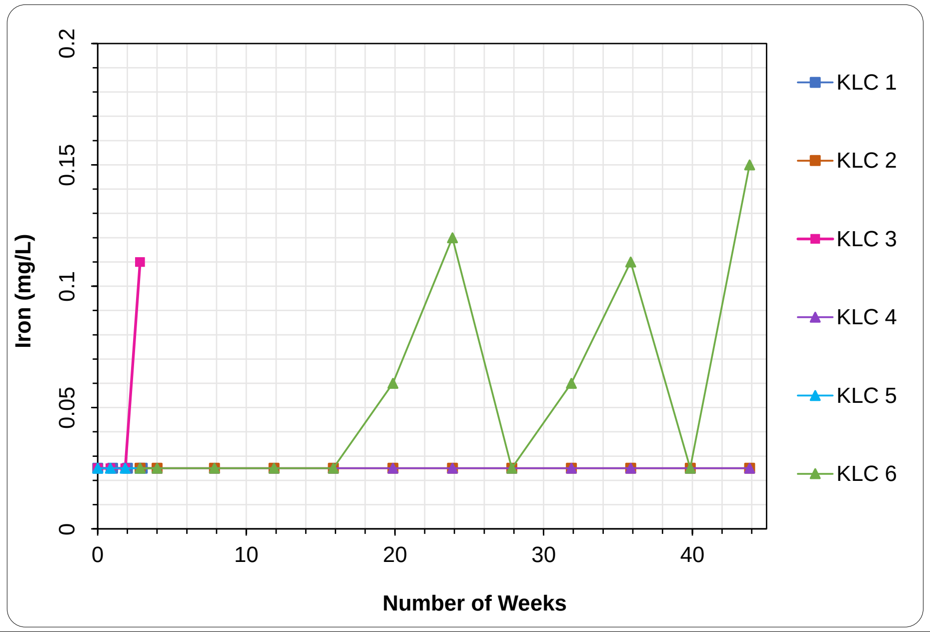

LEGEND:
KLC 1 Roof (Saturated)
KLC 2 Roof (Free Leach)
KLC 3 Coal (Saturated)
KLC 4 Coal (Free Leach)
KLC 5 Floor (Saturated)
KLC 6 Floor (Free Leach)

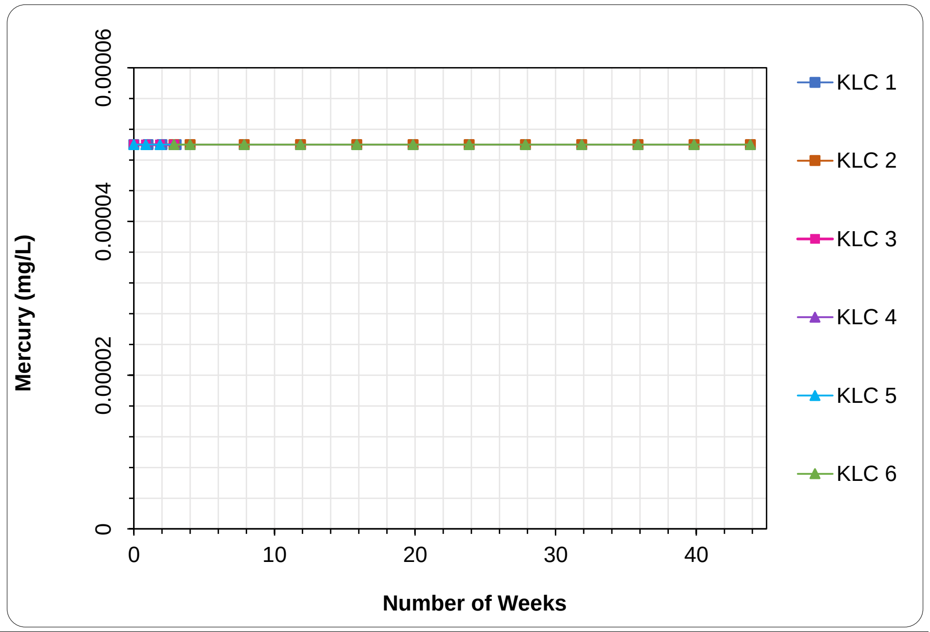

Indium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

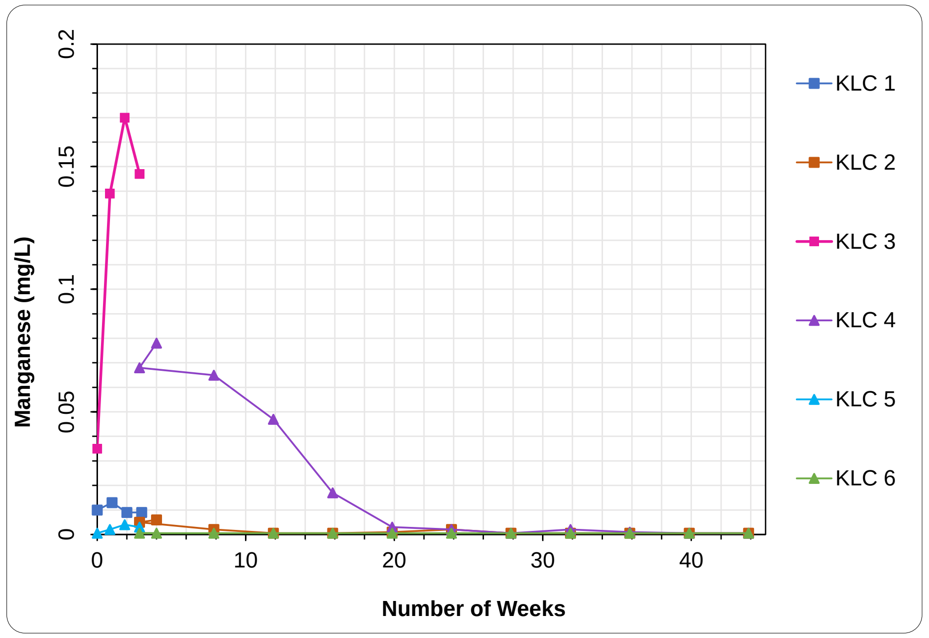

Lanthanum (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

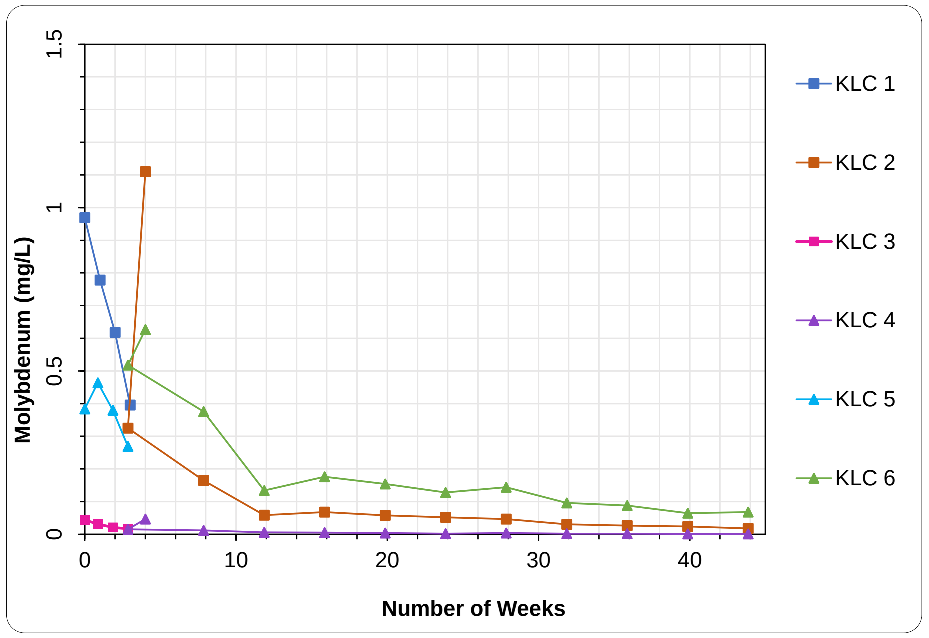

Lithium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6


Lutetium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

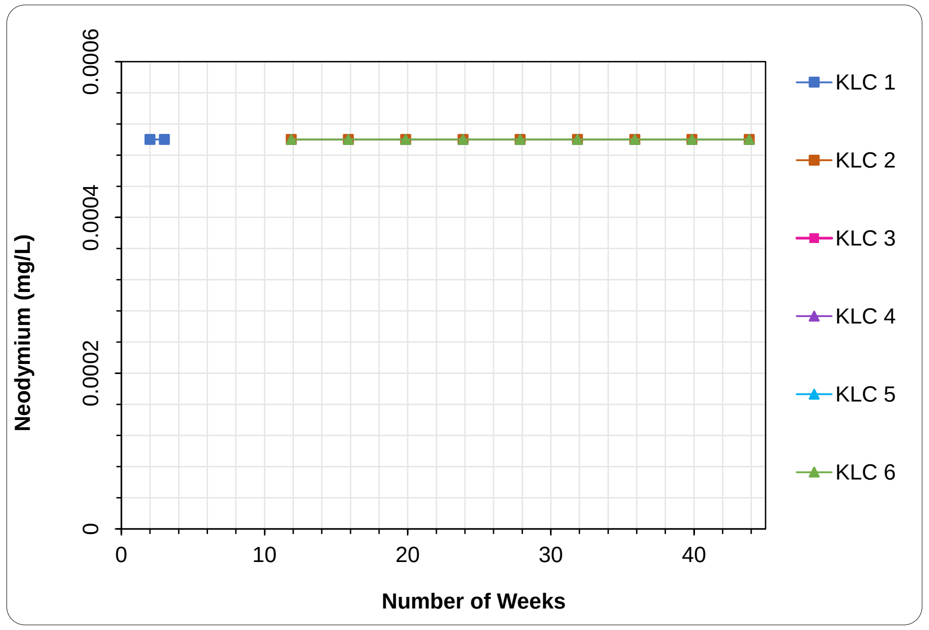

Iron (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

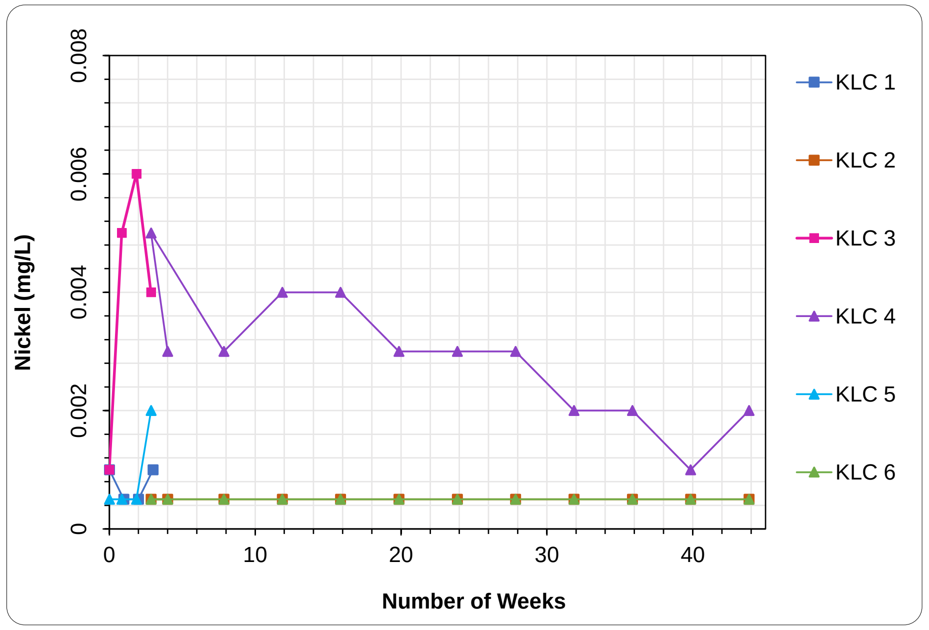

Mercury (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

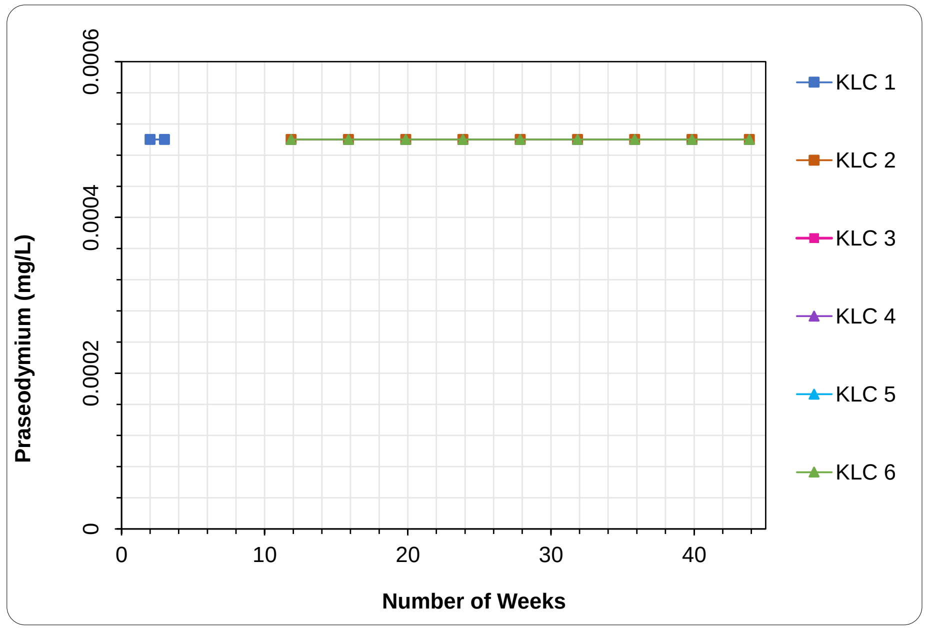

Manganese (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

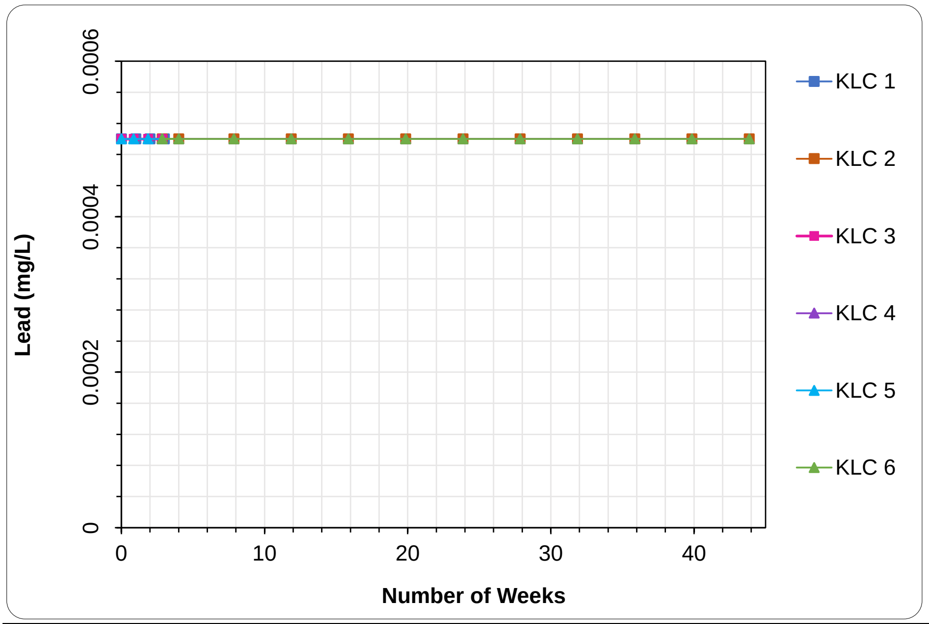

Molybdenum (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

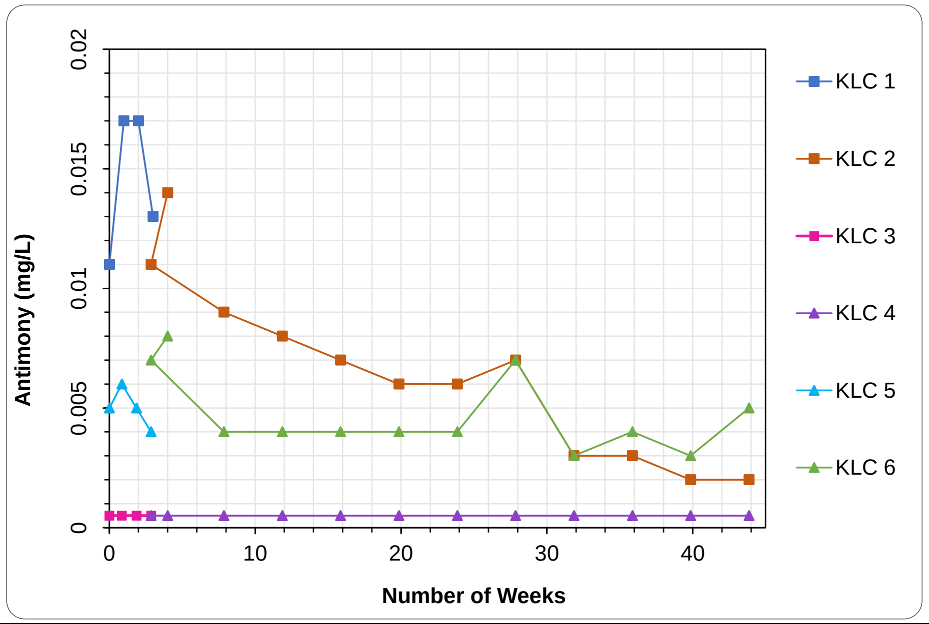

LEGEND:
KLC 1 Roof (Saturated)
KLC 2 Roof (Free Leach)
KLC 3 Coal (Saturated)
KLC 4 Coal (Free Leach)
KLC 5 Floor (Saturated)
KLC 6 Floor (Free Leach)

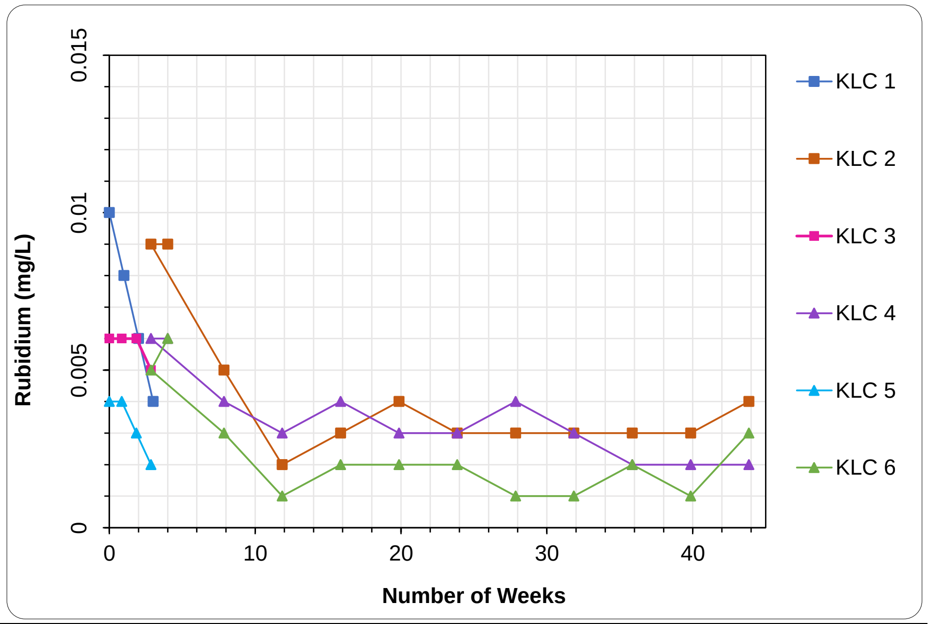

Neodymium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

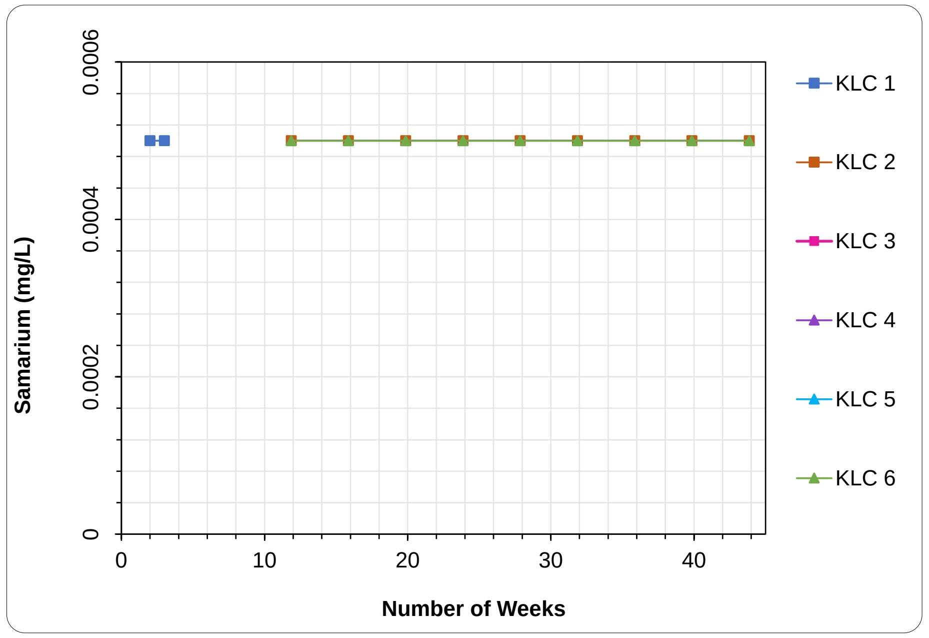

Nickel (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

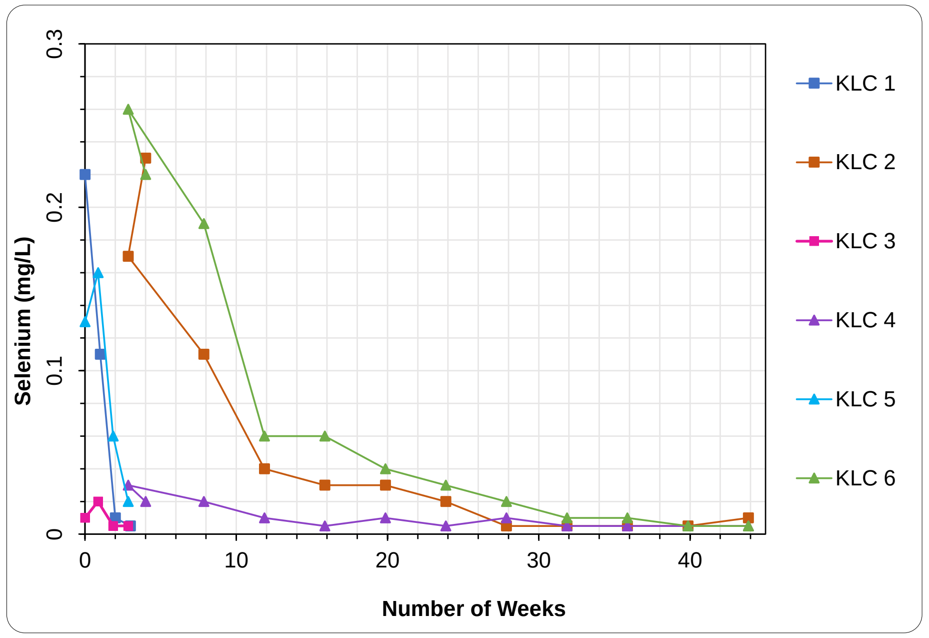

Praseodymium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6


Lead (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

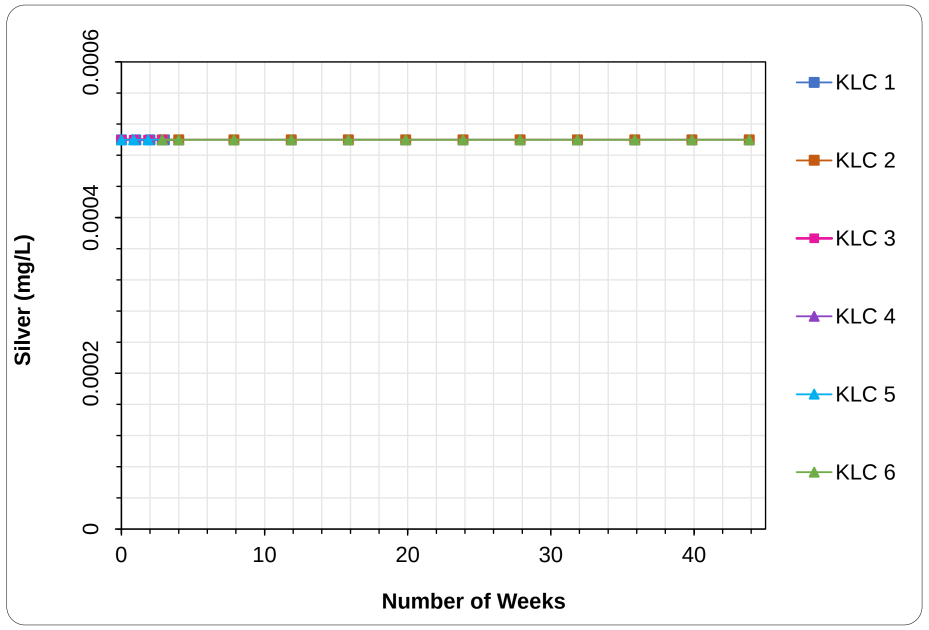

Antimony (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

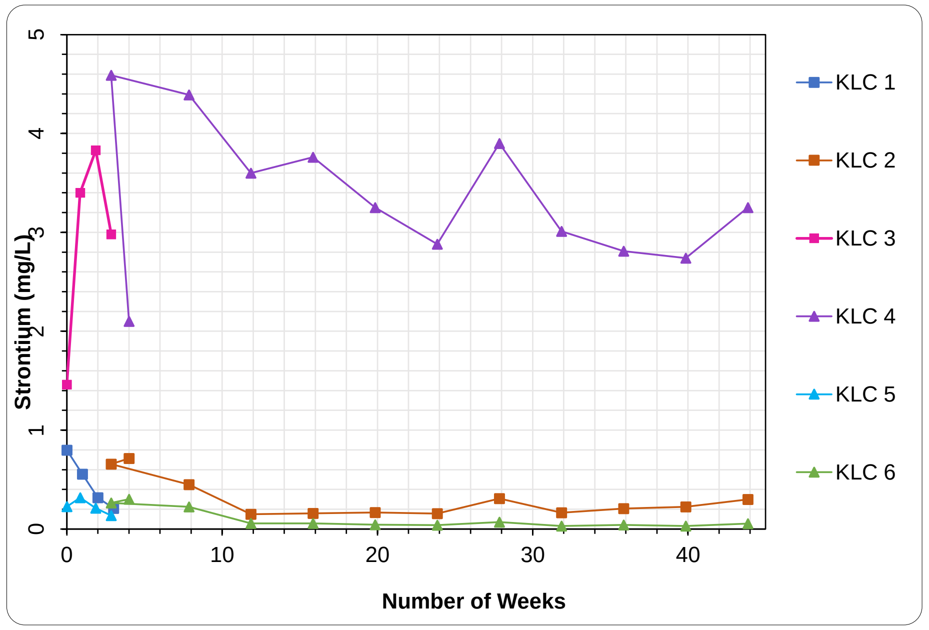

Rubidium (mg/L)
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

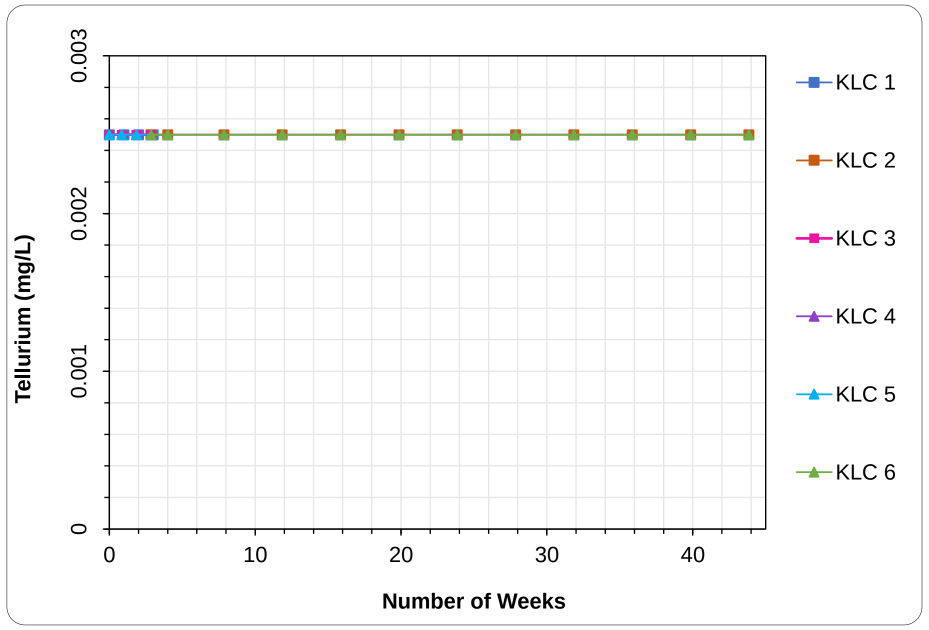

0.0006
0.0004
0.0002
0
Samarium (mg/L)
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

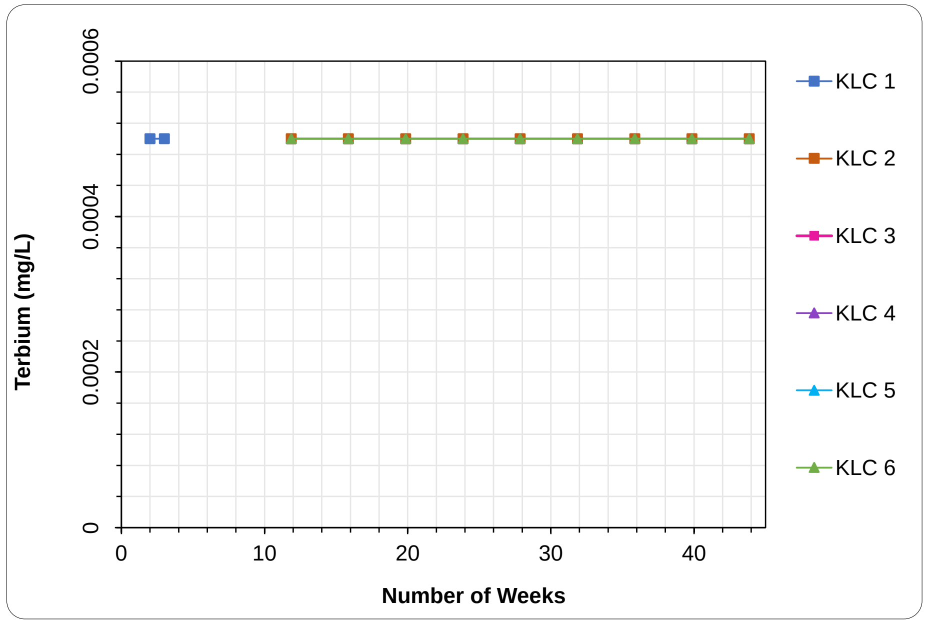

0.3
0.2
0.1
0
Selenium (mg/L)
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

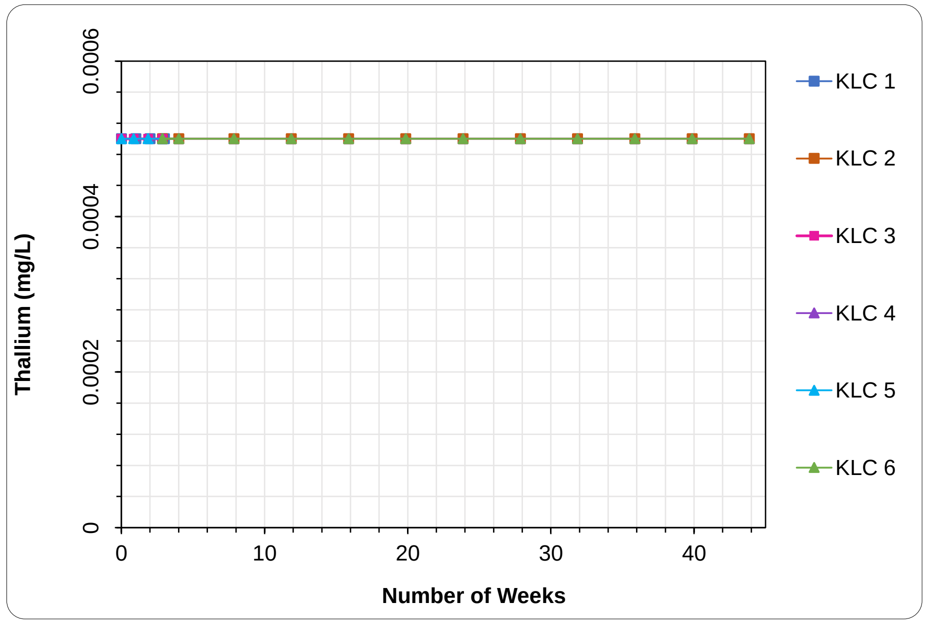

LEGEND:
KLC 1 Roof (Saturated)
KLC 2 Roof (Free Leach)
KLC 3 Coal (Saturated)
KLC 4 Coal (Free Leach)
KLC 5 Floor (Saturated)
KLC 6 Floor (Free Leach)

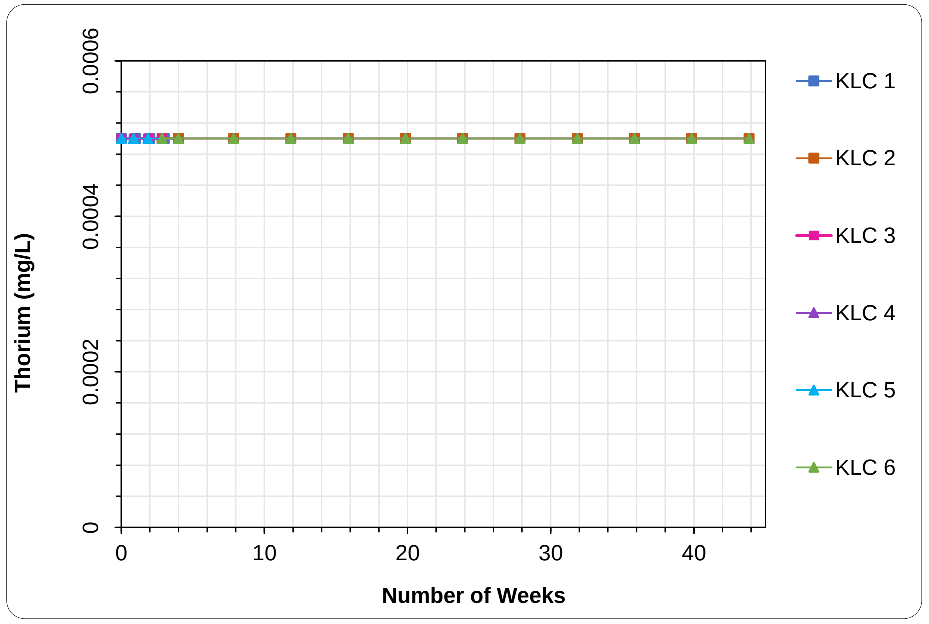

0.0006
0.0004
0.0002
0
Silver (mg/L)
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

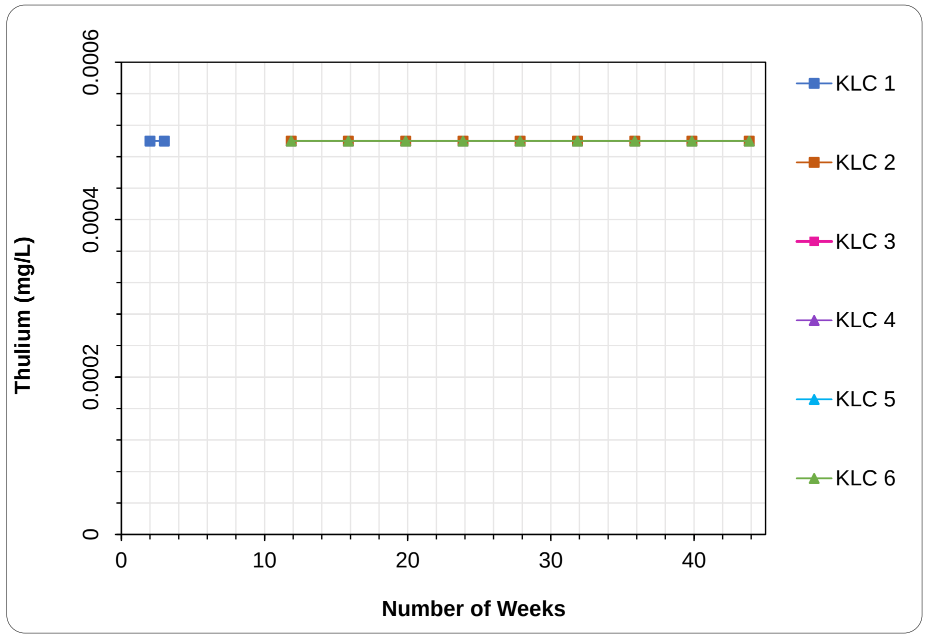

5
4
3
2
1
0
Strontium (mg/L)
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

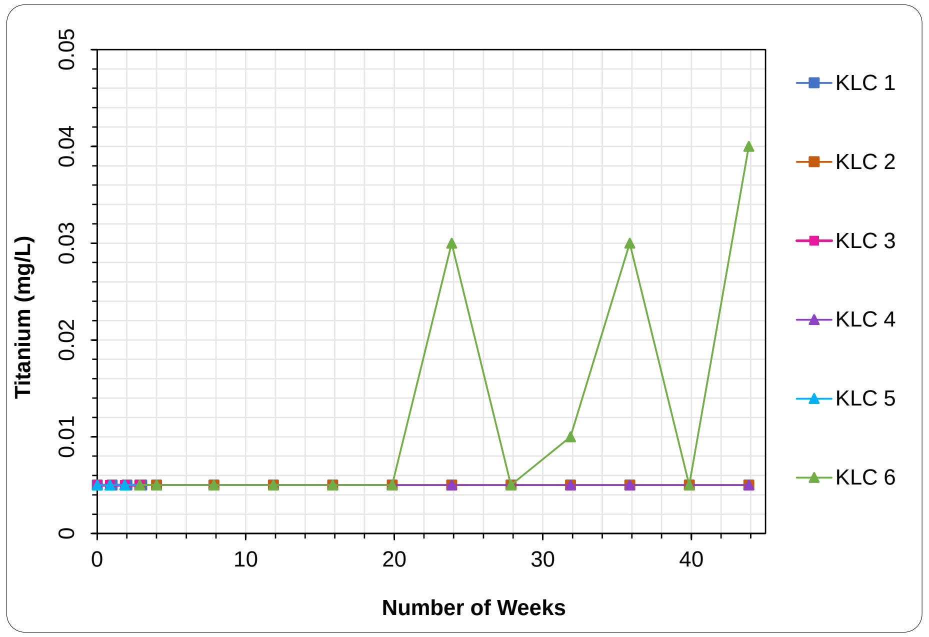

0.003
0.002
0.001
0
Tellurium (mg/L)
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6


0.0006
0.0004
0.0002
0
Terbium (mg/L)
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6


0.0006
0.0004
0.0002
0
Thallium (mg/L)
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

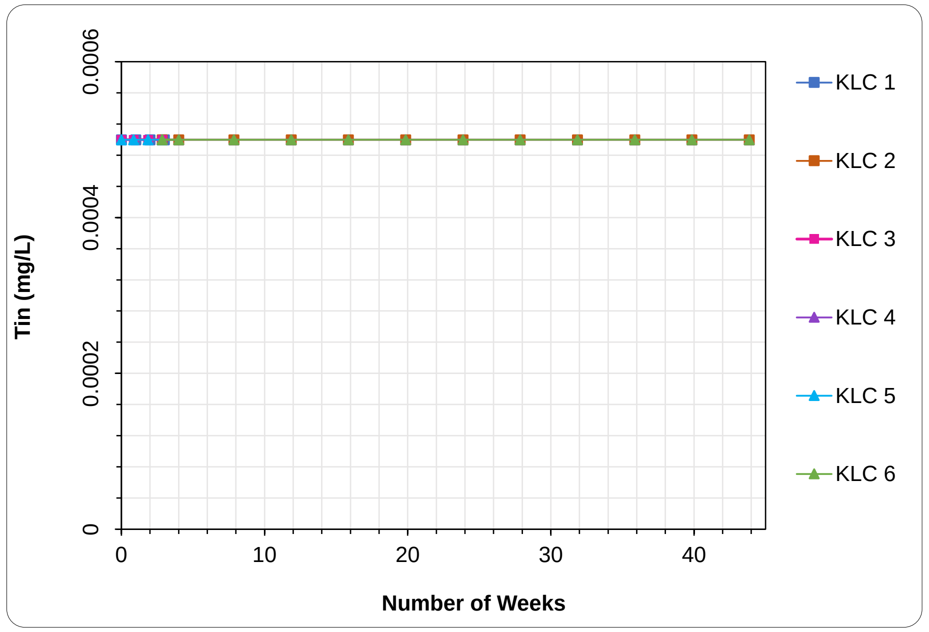

0.0006
0.0004
0.0002
0
Thorium (mg/L)
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

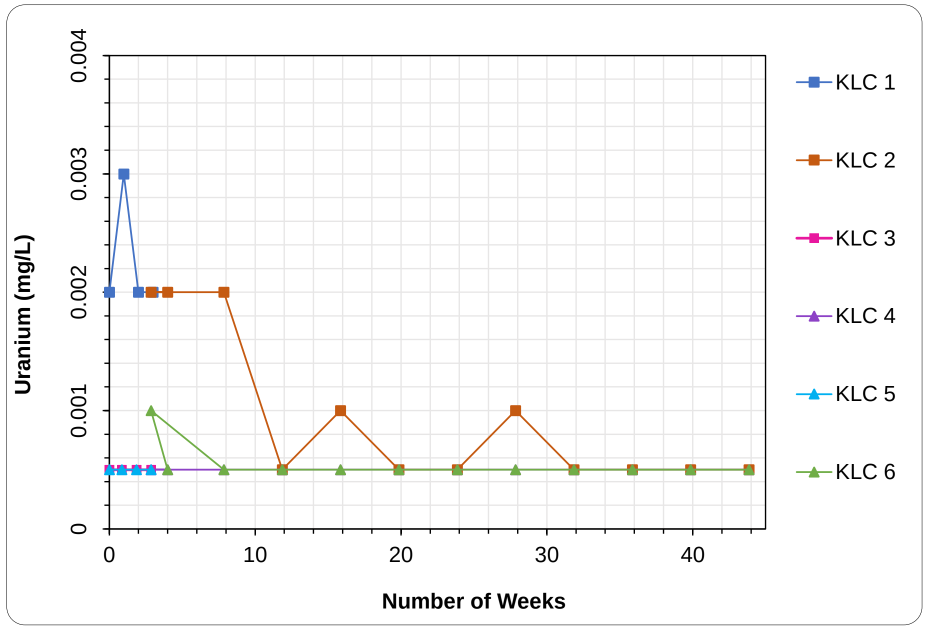


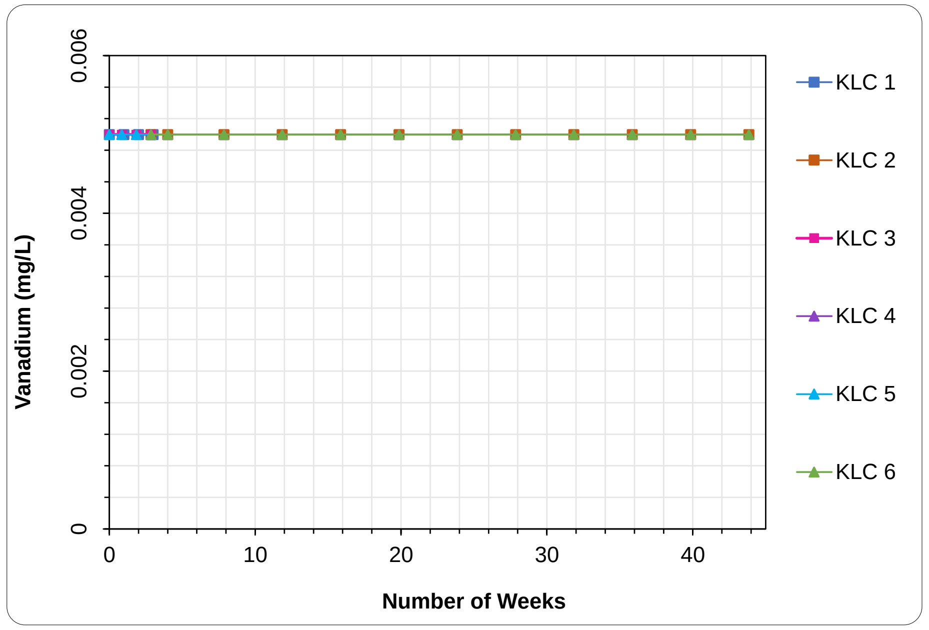


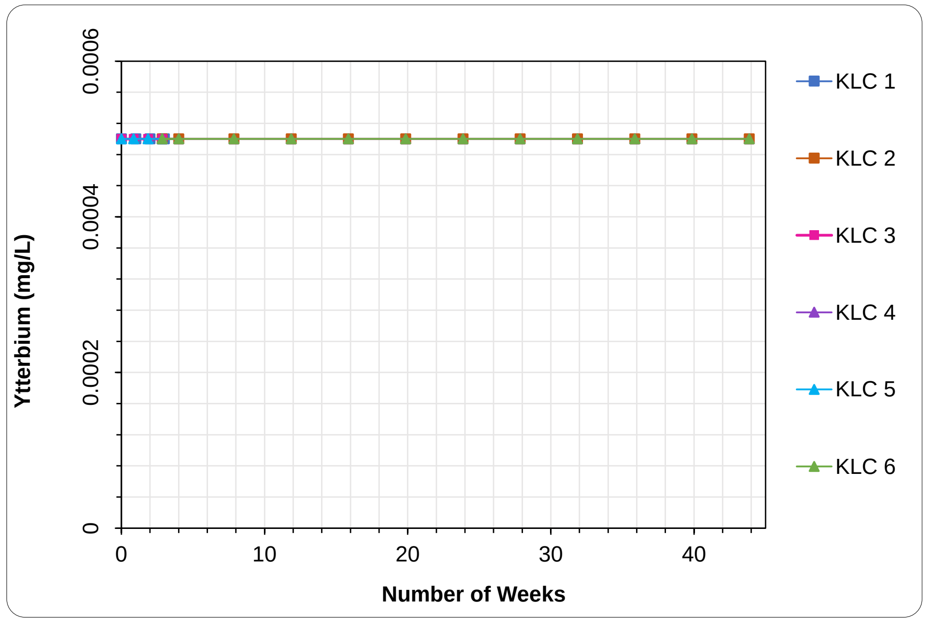
LEGEND:

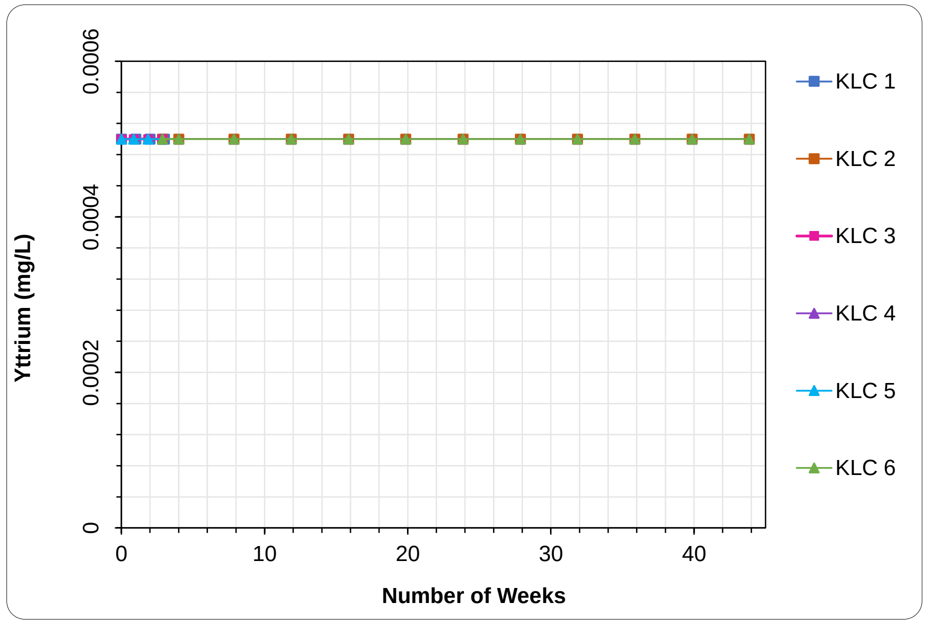
KLC 1 Roof (Saturated)
KLC 2 Roof (Free Leach)
KLC 3 Coal (Saturated)
KLC 4 Coal (Free Leach)
KLC 5 Floor (Saturated)
KLC 6 Floor (Free Leach)

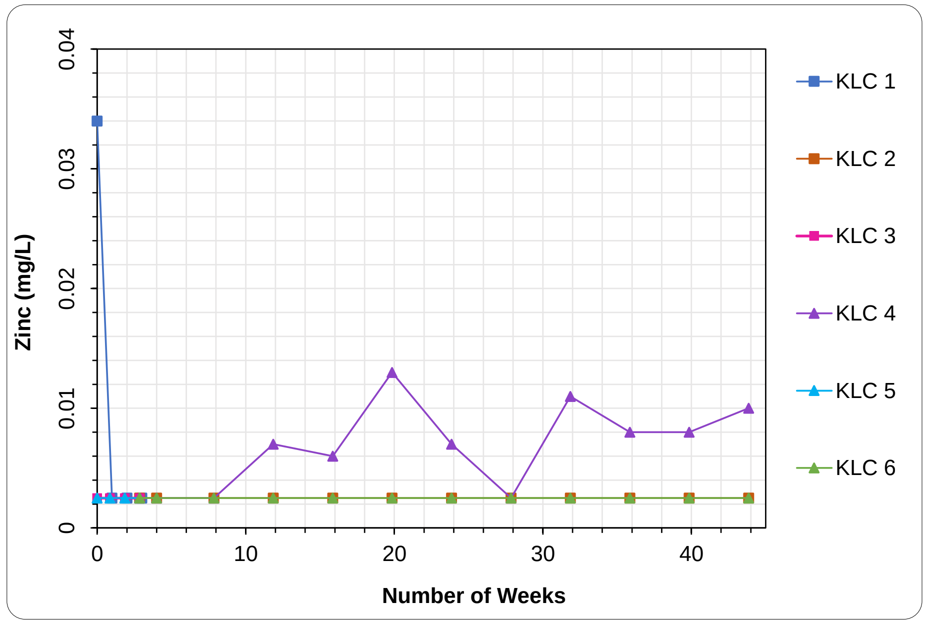




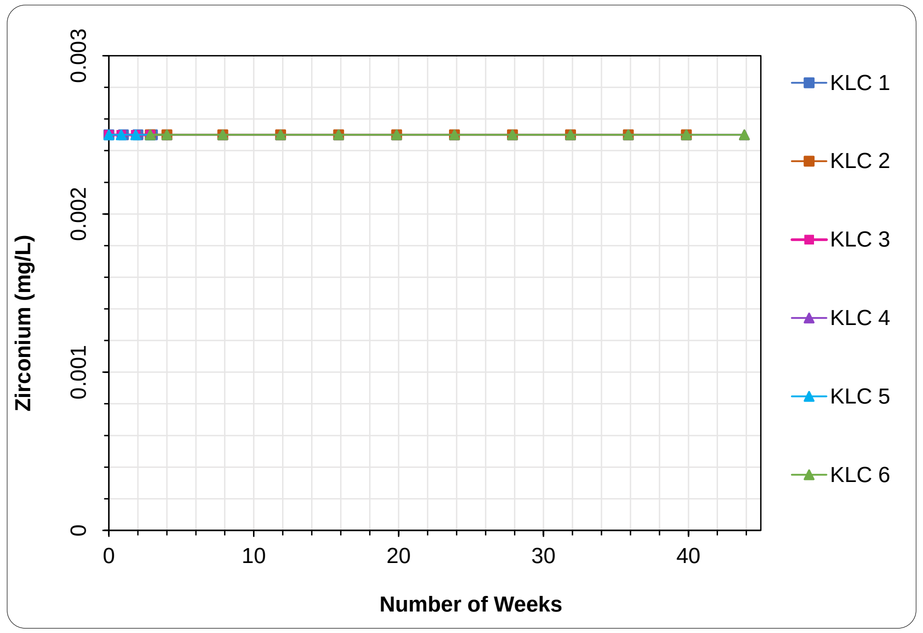


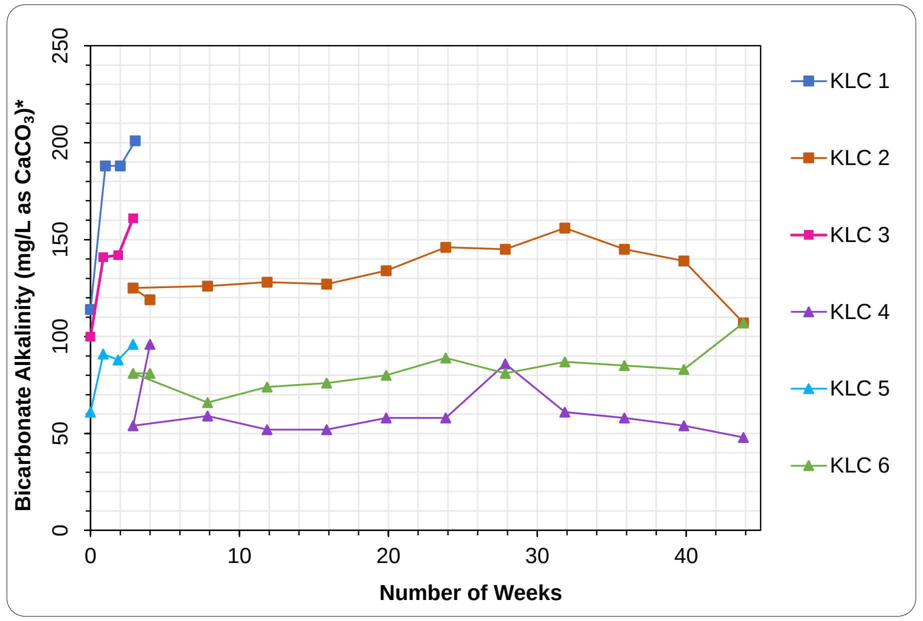


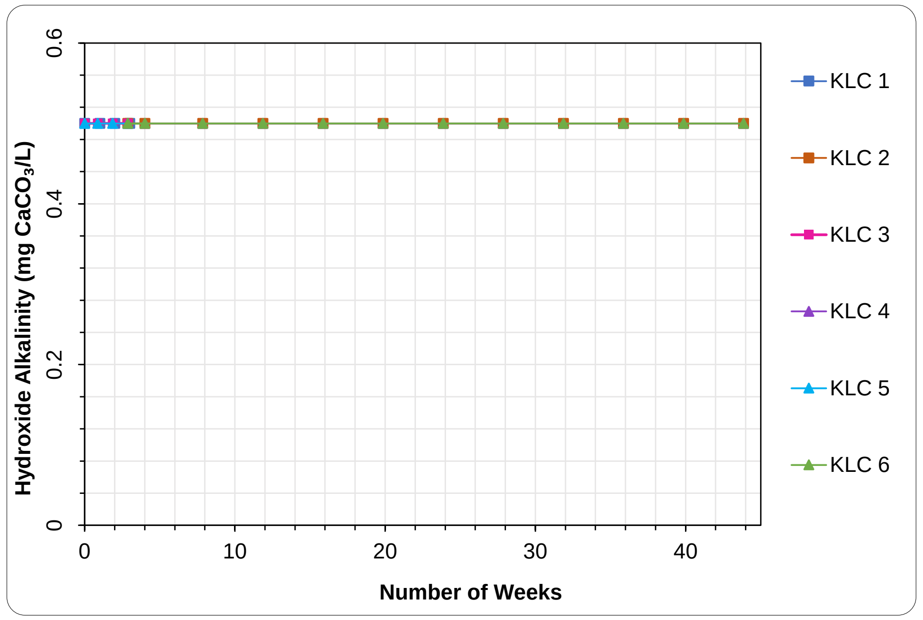


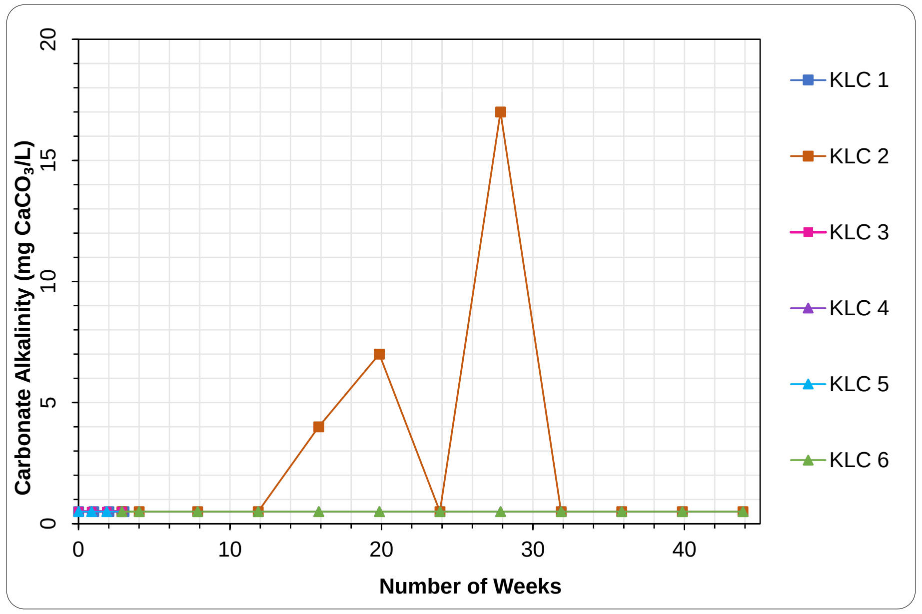


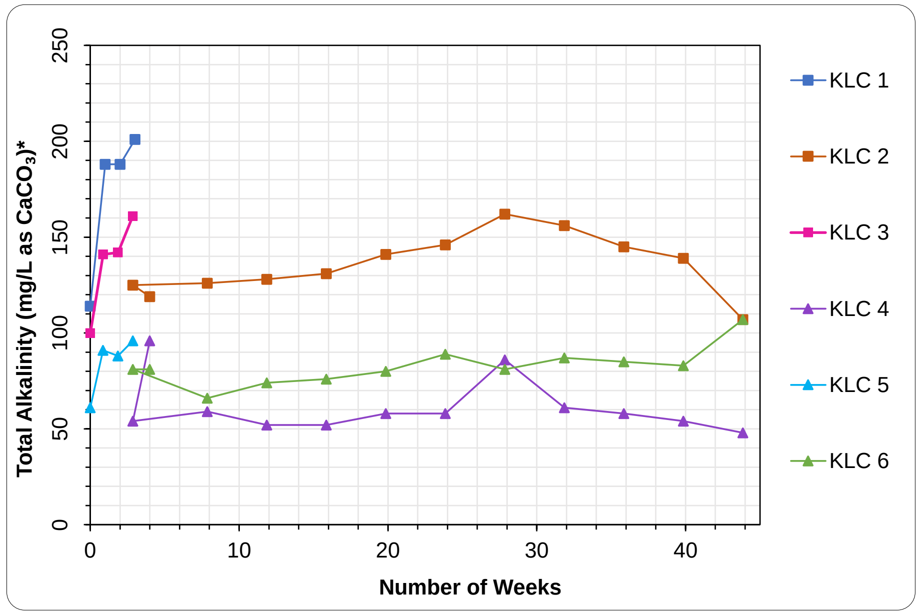
Date of issue: 4.05.2022

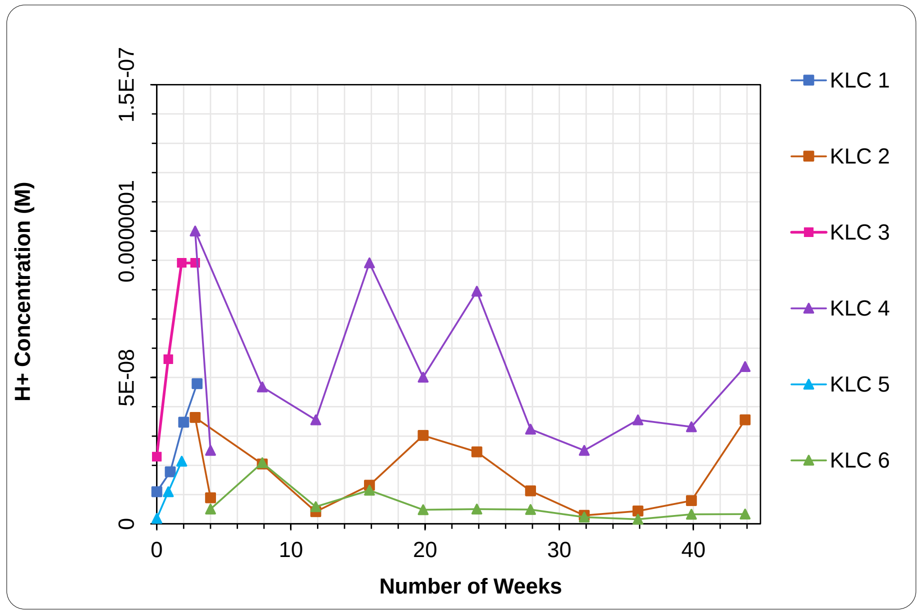












LEGEND:

KLC 1 Roof (Saturated)
KLC 2 Roof (Free Leach)
KLC 3 Coal (Saturated)
KLC 4 Coal (Free Leach)
KLC 5 Floor (Saturated)
KLC 6 Floor (Free Leach)

Table C1: Kinetic Leach Columns for Broadmeadow East Samples

					KLC 1 Roof (Saturated)				KLC 2 Roof (Free Leach)											
Date					30-Apr-21	06-May-21	13-May-21	20-May-21	30-Apr-21	20-May-21	24-Jun-21	22-Jul-21	19-Aug-21	16-Sep-21	14-Oct-21	11-Nov-21	09-Dec-21	06-Jan-22	03-Feb-22	03-Mar-22
Number of Weeks					0	1	2	3	4	3	8	12	16	20	24	28	32	36	40	44
Leach Number					1	2	3	4	1	2	3	4	5	6	7	8	9	10	11	12
ALS Laboratory Number					EB2111789001	EB2112269001	EB2113044001	EB2113873001	EB2111789002	EB2113873002	EB2117702001	EB2120583001	EB2123336001	EB2126300001	EB2129176001	EB2132389001	EB2135901001	EB2200252001	EB2202795001	EB2205849001
Volume On (L)					0.8	1.1	1.1	0.9	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Volume Off (L)					1.050	0.938	0.931	1.567	0.650	1.030	0.685	0.990	0.969	0.968	0.899	0.887	0.899	0.857	0.845	0.620
Cum. Volume (L)			Water Quality Guidelines		1.05	1.99	2.92	4.49	0.65	1.68	2.37	3.36	4.32	5.29	6.19	7.08	7.98	8.83	9.68	10.30
pH (RGS Measurement)			6 to 9	-	7.96	7.75	7.46	7.32	8.05	7.44	7.69	8.38	7.88	7.52	7.61	7.95	8.54	8.36	8.10	7.45
pH (ALS Measurement)				-	8.08	8.15	8.20	8.31	8.17	8.21	8.18	8.27	8.4	8.50	8.25	8.40	8.37	8.15	8.25	8.09
pH (deionised water used in test)			<1,000 #	3,580^	6.67	6.92	5.37	7.25	6.67	7.25	7.06	7.02	6.30	7.64	7.61	6.83	7.27	6.91	5.74	6.38
EC (RGS Measurement) (µS/cm)					1,807	1,291	932	736	1,844	1,537	1,490	632	499	542	450	519	394	342	420	410
EC (ALS Measurement) (µS/cm)			-	-	1850	1360	918	664	1880	1640	1260	817	709	602	612	586	510	502	508	419
Acidity (mg/L as $CaCO_3$)*			-	-	1.0	2.0	2.0	<1	<1	<1	1.0	<1	<1	<1	<1	<1	<1	4	1	<1
Hydroxide Alkalinity (mg/L as $CaCO_3$)*			-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity (mg/L as $CaCO_3$)*			-	-	<1	<1	<1	<1	<1	<1	<1	<1	4.0	7.0	<1	17.0	<1	<1	<1	<1
Bicarbonate Alkalinity (mg/L as $CaCO_3$)*			-	-	114.0	188.0	188.0	201.0	119.0	125.0	126.0	128.0	127	134	146	145	156	145	139	107.0
Total Alkalinity (mg/L as $CaCO_3$)*			-	-	114.0	188.0	188.0	201.0	119.0	125.0	126.0	128.0	131	141	146	162	156	145	139	107.0
Major Ions (mg/L)	Elements	LoR	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]																
Calcium	Ca	1	-	1000	20	11	6	6	18	14	11	4	4	4	4	6	4	5	6	7
Potassium	K	1	-	-	9	7	6	6	9	8	9	4	4	11	4	4	4	5	4	4
Magnesium	Mg	1	-	-	17	10	6	4	14	12	10	3	3	3	3	4	4	5	5	6
Sodium	Na	1	-	-	344	268	202	157	358	308	260	106	106	100	85	112	79	80	72	70
Chloride	Cl	1	-	-	308	165	82	41	317	214	109	44	21	10	7	4	3	3	2	3
Fluoride	F	0.1	-	2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
Sulfate	SO_4	1	-	1000	405	286	153	84	400	426	356	208	163	137	139	114	107	109	108	89
Trace metals/ metalloids (mg/L)	Elements	LoR	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]																
Aluminium	Al	0.01	0.055	5	0.03	0.01	0.03	0.07	0.02	0.04	0.04	0.12	0.18	0.15	0.22	0.1	0.1	0.08	0.12	0.1
Arsenic	As	0.001	0.024	0.5	0.031	0.037	0.039	0.035	0.034	0.023	0.013	0.016	0.014	0.012	0.008	0.005	0.005	0.004	0.003	0.003
Boron	B	0.05	0.37	5	0.16	0.16	0.14	0.1	0.17	----	0.13	0.07	0.07	0.08	0.08	0.06	0.08	0.07	0.07	0.08
Barium	Ba	0.001	-	-	0.044	0.036	0.031	0.037	0.061	0.04	0.048	0.013	0.021	0.024	0.022	0.039	0.02	0.026	0.028	0.034
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	Bi	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	Cd	0.0001	0.0002	0.01	0.0005	0.0003	0.0003	0.0003	0.0005	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	Ce	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	Cs	0.001	-	-	0.002	0.001	<0.001	<0.001	0.002	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	Co	0.001	-	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	Cr	0.001	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	Cu	0.001	0.0014	1	0.002	<0.001	<0.001	<0.001	0.002	<0.001	0.001	0.001	0.001	0.002	0.004	<0.001	0.001	0.002	<0.001	0.002
Dysprosium	Dy	0.001	-	-	----	----	<0.001	<0.001	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	Er	0.001	-	-	----	----	<0.001	<0.001	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Europium	Eu	0.001	-	-	----	----	<0.001	<0.001	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Gadolinium	Gd	0.001	-	-	----	----	<0.001	<0.001	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	Ga	0.001	-	-	----	----	<0.001	<0.001	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	Hf	0.01	-	-	----	----	<0.01	<0.01	----	----	----	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Holmium	Ho	0.001	-	-	----	----	<0.001	<0.001	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Indium	In	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lanthanum	La	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	Li	0.001	-	-	0.017	0.015	0.012	0.009	0.016	0.016	0.016	0.006	0.008	0.007	0.008	0.01	0.01	0.009	0.011	0.014
Lutetium	Lu	0.001	-	-	----	----	<0.001	<0.001	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	Fe	0.05	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	Mn	0.001	1.9	-	0.01	0.013	0.009	0.009	0.006	0.005	0.002	<0.001	<0.001	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	Mo	0.001	-	0.15	0.969	0.778	0.618	0.396	1.11	0.325	0.165	0.059	0.068	0.058	0.052	0.047	0.031	0.027	0.024	0.018
Neodymium	Nd	0.001	-	-	----	----	<0.001	<0.001	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	Ni	0.001	0.011	1	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Praseodymium	Pr	0.001	-	-	----	----	<0.001	<0.001		----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	Pb	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	Sb	0.001	-	-	0.011	0.017	0.017	0.013	0.014	0.011	0.009	0.008	0.007	0.006	0.006	0.007	0.003	0.003	0.002	0.002
Rubidium	Rb	0.001	-	-	0.01	0.008	0.006	0.004	0.009	0.009	0.005	0.002	0.003	0.004	0.003	0.003	0.003	0.003	0.003	0.004
Samarium	Sm	0.001	-	-	----	----	<0.001	<0.001	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	Se	0.01	0.011	0.02	0.220	0.110	0.010	<0.01	0.23	0.17	0.11	0.04	0.03	0.03	0.02	<0.01	<0.01	<0.01	<0.01	0.01
Silver	Ag	0.001	0.00005	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	Sr	0.001	-	-	0.798	0.556	0.316	0.209	0.713	0.657	0.45	0.15	0.159	0.166	0.156	0.308	0.164	0.206	0.224	0.299
Tellurium	Te	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Terbium	Tb	0.001	-	-	----	----	<0.001	<0.001	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	Tl	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	Th	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thulium	Tm	0.001	-	-	----	----	<0.001	<0.001	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	Ti	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tin	Sn	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	U	0.001	-	-	0.002	0.003	0.002	0.002	0.002	0.002	0.002	<0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	V	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ytterbium	Yb	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	Y	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	Zn	0.005	0.008	-	0.034	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zirconium	Zr	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	
Ionic Balance																				
Total Anions	meq/L	-			19.4	----	9.25	6.92	19.6	17.4	13	----	----	----	----	5.72	5.43	5.25	5.08	4.08
Total Cations	meq/L	-			17.6	----	9.73	7.61	17.8	15.3	12.9	----	----	----	----	5.6	4.07	4.27	3.94	3.99
Ionic Balance	%	-			4.89	----	2.52	4.74	4.79	6.47	0.36	----	----	----	----	1.06	----	10.3	12.6	1.06
Calculations**	Elements																			
SO_4 Release Rate	SO_4				142	89	47	44	87	146	81	69	53	44	42	34	32	31	30	18
Cumulative SO_4 Release	Cum SO_4				142	231	279	323	87	233	314	383	436	480	521	555	587	618	649	667
Ca Release Rate	Ca				7.0	3.4	1.9	3.1	3.9	4.8	2.5	1.3	1.3	1.3	1.2	1.8	1.2	1.4	1.7	1.4
Cumulative Ca Release	Cum Ca				7.0	10.4	12.3	15.4	3.9	8.7	11.2	12.5	13.8	15.1	16.3	18.1	19.3	20.7	22.4	23.9
Mg Release Rate	Mg				6.0	3.1	1.9	2.1	3.0	4.1	2.3	1.0	1.0	1.0	0.9	1.2	1.2	1.4	1.4	1.2
Cumulative Mg Release	Cum Mg				6.0	9.1	10.9	13.0	3.0	7.2	9.4	10.4	11.4	12.4	13.3	14.4	15.6	17.1	18.5	19.7
Residual ANC (%)	Res. ANC				99.9	99.9	99.9	99.9	99.9	99.9	99.8	99.8	99.8	99.7	99.7	99.7	99.7	99.6	99.6	99.6
Residual Sulfur (%)	Res. S				97.8	96.4	95.7	95.0	99.6	99.0	98.7	98.4	98.2	98.0	97.8	97.7	97.6	97.4	97.3	97.2
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				3.5	4.3	4.0	2.8	4.1	5.3	5.4	9.7	7.6	6.4	6.5	3.8	4.2	3.4	3.2	2.2

Notes:

ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. # for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm * Acidity and alkalinity data calculated in mg CaCO3/L. Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent. # for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm ** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.

RGS

Table C1: Kinetic Leach Columns for Broadmeadow East Samples

					KLC 3 Coal (Saturated)				KLC 4 Coal (Free Leach)											
Date					30-Apr-21	06-May-21	13-May-21	20-May-21	30-Apr-21	20-May-21	24-Jun-21	22-Jul-21	19-Aug-21	16-Sep-21	14-Oct-21	11-Nov-21	09-Dec-21	06-Jan-22	03-Feb-22	03-Mar-22
Number of Weeks					0	1	2	3	4	3	8	12	16	20	24	28	32	36	40	44
Leach Number					1	2	3	4	1	2	3	4	5	6	7	8	9	10	11	12
ALS Laboratory Number					EB2111789003	EB2112269002	EB2113044002	EB2113873003	EB2111789004	EB2113873004	EB2117702002	EB2120583002	EB2123336002	EB2126300002	EB2129176002	EB2132389002	EB2135901002	EB2200252002	EB2202795002	EB2205849002
Volume On (L)					0.4	1.2	0.7	0.7	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.5
Volume Off (L)					1.135	0.616	0.617	0.928	0.767	1.000	0.729	0.923	0.915	0.896	0.870	0.946	0.823	0.763	0.766	0.733
Cum. Volume (L)			Water Quality Guidelines		1.14	1.75	2.37	3.30	0.77	1.77	2.50	3.42	4.33	5.23	6.10	7.05	7.87	8.63	9.40	10.13
pH (RGS Measurement)			6 to 9	-	7.64	7.25	7.05	7.05	7.60	7.00	7.33	7.45	7.05	7.30	7.10	7.49	7.60	7.45	7.48	7.27
pH (ALS Measurement)				-	7.84	7.88	7.95	7.97	8.00	7.83	7.80	7.78	7.88	8.00	7.77	7.92	7.69	7.42	7.17	7.46
pH (deionised water used in test)			<1,000 #	3,580^	6.67	6.92	5.37	7.25	6.67	7.25	7.06	7.02	6.30	7.64	7.61	6.83	7.27	6.91	5.74	6.38
EC (RGS Measurement) (µS/cm)					1,211	1,477	1,566	1,261	1,390	1,760	1,873	1,297	1,025	1,077	1,006	1,142	945	737	974	996
EC (ALS Measurement) (µS/cm)			-	-	1350	1910	1730	1280	1480	2110	1790	1840	1550	1,530	1,300	1,260	1090	1,170	1,160	1010
Acidity (mg/L as $CaCO_3$)*			-	-	3.0	5.0	4.0	8.0	3.0	4.0	3.0	2.0	3.0	5.0	7.0	5.0	3	6.0	8.0	3.0
Hydroxide Alkalinity (mg/L as $CaCO_3$)*			-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity (mg/L as $CaCO_3$)*			-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity (mg/L as $CaCO_3$)*			-	-	100.0	141.0	142.0	161.0	96.0	54.0	59.0	52.0	52.0	58.0	58.0	86.0	61	58	54	48.0
Total Alkalinity (mg/L as $CaCO_3$)*			-	-	100.0	141.0	142.0	161.0	96.0	54.0	59.0	52.0	52.0	58.0	58.0	86.0	61	58	54	48.0
Major Ions (mg/L)	Elements	LoR	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]																
Calcium	Ca	1	-	1000	48	84	94	75	64	118	135	111	118	97	98	137	116	121	122	130
Potassium	K	1	-	-	5	7	6	6	5	7	6	4	4	4	4	4	3	3	2	3
Magnesium	Mg	1	-	-	19	36	40	31	26	46	57	39	42	39	38	52	40	44	42	50
Sodium	Na	1	-	-	201	228	247	187	220	272	216	116	99	66	43	52	24	20	13	13
Chloride	Cl	1	-	-	83	108	94	62	94	92	48	45	27	14	7	4	2	3	2	2
Fluoride	F	0.1	-	2	0.1	0.1	<0.1	0.2	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.2	0.1	<0.1	0.1	0.1	0.1
Sulfate	SO_4	1	-	1000	476	772	675	444	549	969	861	924	746	799	670	615	565	622	610	526
Trace metals/ metalloids (mg/L)	Elements	LoR	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]																
Aluminium	Al	0.01	0.055	5	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.01	<0.01	0.01
Arsenic	As	0.001	0.024	0.5	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	B	0.05	0.37	5	<0.05	<0.05	----	----	<0.05	----	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Barium	Ba	0.001	-	-	0.063	0.042	0.039	0.043	0.076	0.041	0.035	0.02	0.028	0.023	0.022	0.029	0.033	0.021	0.022	0.034
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	Bi	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	Ce	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	Cs	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	Co	0.001	-	1	<0.001	0.002	0.002	0.001	0.001	0.002	0.002	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	Cr	0.001	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	Cu	0.001	0.0014	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
Dysprosium	Dy	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	Er	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Europium	Eu	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Gadolinium	Gd	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	Ga	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	Hf	0.01	-	-	----	----	----	----	----	----	----	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Holmium	Ho	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Indium	In	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lanthanum	La	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	Li	0.001	-	-	0.016	0.027	0.026	0.023	0.02	0.024	0.026	0.02	0.023	0.01	0.02	0.031	0.025	0.022	0.027	0.03
Lutetium	Lu	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	Fe	0.05	-	-	<0.05	<0.05	<0.05	0.11	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	Mn	0.001	1.9	-	0.035	0.139	0.17	0.147	0.078	0.068	0.065	0.047	0.017	0.003	0.002	<0.001	0.002	0.001	<0.001	<0.001
Molybdenum	Mo	0.001	-	0.15	0.044	0.032	0.021	0.017	0.047	0.015	0.012	0.006	0.005	0.004	0.002	0.004	0.002	0.002	0.001	0.001
Neodymium	Nd	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	Ni	0.001	0.011	1	0.001	0.005	0.006	0.004	0.003	0.005	0.003	0.004	0.004	0.003	0.003	0.003	0.002	0.002	0.001	0.002
Praseodymium	Pr	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	Pb	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	Sb	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	Rb	0.001	-	-	0.006	0.006	0.006	0.005	0.006	0.006	0.004	0.003	0.004	0.003	0.003	0.004	0.003	0.002	0.002	0.002
Samarium	Sm	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	Se	0.01	0.011	0.02	0.01	0.02	<0.01	<0.01	0.02	0.03	0.02	0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
Silver	Ag	0.001	0.00005	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	Sr	0.001	-	-	1.46	3.4	3.83	2.98	2.1	4.59	4.39	3.6	3.76	3.25	2.88	3.9	3.01	2.81	2.74	3.25
Tellurium	Te	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Terbium	Tb	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	Tl	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	Th	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thulium	Tm	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	Ti	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tin	Sn	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	U	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	V	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ytterbium	Yb	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	Y	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	Zn	0.005	0.008	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.007	0.006	0.013	0.007	<0.005	0.011	0.008	0.008	0.01
Zirconium	Zr	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ionic Balance																				
Total Anions	meq/L	-			14.2	----	19.5	14.2	16	23.8	20.4	----	----	----	----	14.6	13	14.2	13.8	12
Total Cations	meq/L	-			12.8	----	18.9	14.6	15	21.7	21	----	----	----	----	13.5	10.2	10.6	10.2	11.2
Ionic Balance	%	-			5.24	----	1.72	1.29	3.12	4.75	1.25	----	----	----	----	4.11	----	14.5	15.3	3.11
Calculations**	Elements																			
SO_4 Release Rate	SO_4				180	159	139	137	140	323	209	284	228	239	194	194	155	158	156	129
Cumulative SO_4 Release	Cum SO_4				180	339	477	615	140	463	673	957	1184	1423	1617	1811	1966	2124	2280	2409
Ca Release Rate	Ca				18.2	17.2	19.3	23.2	16.4	39.3	32.8	34.2	36.0	29.0	28.4	43.2	31.8	30.8	31.2	31.8
Cumulative Ca Release	Cum Ca				18.2	35.4	54.7	77.9	16.4	55.7	88.5	122.7	158.6	187.6	216.0	259.2	291.1	321.8	353.0	384.7
Mg Release Rate	Mg				7.2	7.4	8.2	9.6	6.6	15.3	13.9	12.0	12.8	11.6	11.0	16.4	11.0	11.2	10.7	12.2
Cumulative Mg Release	Cum Mg				7.2	14.6	22.8	32.4	6.6	22.0	35.8	47.8	60.6	72.3	83.3	99.7	110.7	121.9	132.6	144.8
Residual ANC (%)	Res. ANC				99.3	98.7	98.0	97.1												
Residual Sulfur (%)	Res. S				95.3	91.2	87.6	84.0												
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				2.5	2.2	1.8	1.5	2.1	2.1	1.6	2.2	1.7	2.1	1.7	1.2	1.3	1.3	1.3	1.0

Notes:

ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. # for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm * Acidity and alkalinity data calculated in mg CaCO3/L. Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent. # for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm ** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.

Table C1: Kinetic Leach Columns for Broadmeadow East Samples

					KLC 5 Floor (Saturated)				KLC 6 Floor (Free Leach)											
Date					**30-Apr-21**	**06-May-21**	**13-May-21**	**20-May-21**	**30-Apr-21**	**20-May-21**	**24-Jun-21**	**22-Jul-21**	**19-Aug-21**	**16-Sep-21**	**14-Oct-21**	**11-Nov-21**	**09-Dec-21**	**06-Jan-22**	**03-Feb-22**	**03-Mar-22**
Number of Weeks					**0**	**1**	**2**	**3**	**4**	**3**	**8**	**12**	**16**	**20**	**24**	**28**	**32**	**36**	**40**	**44**
Leach Number					**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
ALS Laboratory Number					EB2111789005	EB2112269003	EB2113044003	EB2113873005	EB2111789006	EB2113873006	EB2117702003	EB2120583003	EB2123336003	EB2126300003	EB2129176003	EB2132389003	EB2135901003	EB2200252003	EB2202795003	EB2205849003
Volume On (L)					1.3	1.0	0.9	0.9	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Volume Off (L)					1.001	0.874	0.862	1.325	0.559	1.038	0.611	0.831	0.916	0.941	0.915	0.840	0.852	0.814	0.826	0.575
Cum. Volume (L)			**Water Quality Guidelines**		1.00	1.88	2.74	4.06	0.56	1.60	2.21	3.04	3.96	4.90	5.81	6.65	7.50	8.32	9.14	9.72
pH (RGS Measurement)			6 to 9	-	8.73	7.96	7.67	----	8.30	----	7.68	8.23	7.94	8.32	8.30	8.31	8.64	8.81	8.49	8.48
pH (ALS Measurement)				-	8.21	7.69	7.96	8.02	8.01	8.12	8.06	8.15	8.21	8.24	8.13	8.17	8.12	8.07	8.13	8.08
pH (deionised water used in test)			<1,000 #	3,580^	6.67	6.92	5.37	7.25	6.67	7.25	7.06	7.02	6.30	7.64	7.61	6.83	7.27	6.91	5.74	6.38
EC (RGS Measurement) (µS/cm)					748	857	734	562	1,138	1,128	1,040	481	389	308	268	303	237	213	222	243
EC (ALS Measurement) (µS/cm)			-	-	760	891	720	531	1150	1080	967	618	537	414	391	363	308	310	301	251
Acidity (mg/L as $CaCO_3$)*			-	-	<1	3.0	2.0	2.0	2.0	<1	2.0	<1	<1	<1	<1	2.0	<1	<1	<1	<1
Hydroxide Alkalinity (mg/L as $CaCO_3$)*			-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity (mg/L as $CaCO_3$)*			-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity (mg/L as $CaCO_3$)*			-	-	61.0	91.0	88.0	96.0	81.0	81.0	66.0	74.0	76.0	80.0	89.0	81.0	87	85	83	107.0
Total Alkalinity (mg/L as $CaCO_3$)*			-	-	61.0	91.0	88.0	96.0	81.0	81.0	66.0	74.0	76.0	80.0	89.0	81.0	87	85	83	107.0
Major Ions (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**																
Calcium	**Ca**	1	-	1000	4	6	5	3	11	7	4	1	1	<1	<1	1	<1	<1	<1	<1
Potassium	**K**	1	-	-	4	5	4	3	5	5	5	7	2	4	2	2	2	3	1	2
Magnesium	**Mg**	1	-	-	2	3	2	1	4	3	2	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium	**Na**	1	-	-	146	176	144	114	221	234	188	80	79	66	55	69	51	58	46	52
Chloride	**Cl**	1	-	-	142	158	109	63	228	180	106	43	22	11	6	3	2	1	1	<1
Fluoride	**F**	0.1	-	2	0.3	0.3	0.2	0.2	0.4	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1
Sulfate	**SO_4**	1	-	1000	101	123	102	70	162	192	205	126	114	95	86	71	66	66	61	48
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**																
Aluminium	**Al**	0.01	0.055	5	0.13	0.08	0.11	0.21	0.05	0.1	0.16	0.25	0.33	0.4	0.98	0.26	0.44	0.97	0.24	1.25
Arsenic	**As**	0.001	0.024	0.5	0.088	0.068	0.058	0.063	0.122	0.08	0.03	0.049	0.04	0.048	0.052	0.04	0.034	0.034	0.027	0.032
Boron	**B**	0.05	0.37	5	0.1	0.1	----	----	0.14	----	0.07	0.05	<0.05	0.06	<0.05	<0.05	0.06	0.07	0.06	0.08
Barium	**Ba**	0.001	-	-	0.069	0.092	0.064	0.049	0.054	0.025	0.054	0.013	0.019	0.014	0.016	0.026	0.014	0.019	0.012	0.022
Beryllium	**Be**	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	**Bi**	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	**Cd**	0.0001	0.0002	0.01	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	**Ce**	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	**Cs**	0.001	-	-	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	**Co**	0.001	-	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	**Cr**	0.001	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	**Cu**	0.001	0.0014	1	0.004	0.001	<0.001	<0.001	0.004	0.002	0.002	0.002	0.001	0.005	0.005	0.005	0.005	0.004	0.004	0.006
Dysprosium	**Dy**	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	**Er**	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Europium	**Eu**	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Gadolinium	**Gd**	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	**Ga**	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	**Hf**	0.01	-	-	----	----	----	----	----	----	----	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Holmium	**Ho**	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Indium	**In**	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lanthanum	**La**	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	**Li**	0.001	-	-	0.006	0.007	0.007	0.006	0.009	0.012	0.013	0.005	0.006	0.005	0.005	0.005	0.006	0.006	0.006	0.007
Lutetium	**Lu**	0.001	-	-			----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	**Fe**	0.05	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.12	<0.05	0.06	0.11	<0.05	0.15
Mercury	**Hg**	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	**Mn**	0.001	1.9	-	<0.001	0.002	0.004	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	**Mo**	0.001	-	0.15	0.384	0.464	0.380	0.269	0.627	0.518	0.376	0.134	0.176	0.154	0.128	0.144	0.096	0.088	0.065	0.068
Neodymium	**Nd**	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	**Ni**	0.001	0.011	1	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Praseodymium	**Pr**	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	**Pb**	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	**Sb**	0.001	-	-	0.005	0.006	0.005	0.004	0.008	0.007	0.004	0.004	0.004	0.004	0.004	0.007	0.003	0.004	0.003	0.005
Rubidium	**Rb**	0.001	-	-	0.004	0.004	0.003	0.002	0.006	0.005	0.003	0.001	0.002	0.002	0.002	0.001	0.001	0.002	0.001	0.003
Samarium	**Sm**	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	**Se**	0.01	0.011	0.02	0.130	0.160	0.060	0.02	0.22	0.26	0.19	0.06	0.06	0.04	0.03	0.02	0.01	0.01	<0.01	<0.01
Silver	**Ag**	0.001	0.00005	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	**Sr**	0.001	-	-	0.226	0.316	0.212	0.136	0.301	0.265	0.224	0.056	0.056	0.043	0.04	0.07	0.031	0.041	0.031	0.054
Tellurium	**Te**	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Terbium	**Tb**	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	**Tl**	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	**Th**	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thulium	**Tm**	0.001	-	-	----	----	----	----	----	----	----	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	**Ti**	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.01	0.03	<0.01	0.04
Tin	**Sn**	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	**U**	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	**V**	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ytterbium	**Yb**	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	**Y**	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	**Zn**	0.005	0.008	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zirconium	**Zr**	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ionic Balance																				
Total Anions	**meq/L**	-			7.33	----	6.96	5.15	11.4	10.7	8.58	----	----	----	----	3.18	3.17	3.1	2.96	2.3
Total Cations	**meq/L**	-			6.82	----	6.78	5.27	10.6	10.9	8.67	----	----	----	----	3.1	2.27	2.6	2.03	2.31
Ionic Balance	**%**	-			3.61	----	1.29	1.1	3.65	0.97	0.54	----	----	----	----	1.26	----	8.79	----	----
Calculations**	**Elements**																			
SO_4 Release Rate	**SO_4**				34	36	29	31	30	66	42	35	35	30	26	20	19	18	17	9
Cumulative SO_4 Release	**Cum SO_4**				34	70	99	130	30	97	138	173	208	238	264	284	303	321	337	347
Ca Release Rate	**Ca**				1.3	1.7	1.4	1.3	2.0	2.4	0.8	0.3	0.3	0.2	0.2	0.3	0.1	0.1	0.1	0.1
Cumulative Ca Release	**Cum Ca**				1.3	3.1	4.5	5.8	2.0	4.5	5.3	5.6	5.9	6.0	6.2	6.5	6.6	6.7	6.9	7.0
Mg Release Rate	**Mg**				0.7	0.9	0.6	0.4	0.7	1.0	0.4	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Cumulative Mg Release	**Cum Mg**				0.7	1.5	2.1	2.6	0.7	1.8	2.2	2.3	2.5	2.6	2.8	2.9	3.1	3.2	3.3	3.4
Residual ANC (%)	**Res. ANC**																			
Residual Sulfur (%)	**Res. S**																			
SO_4/(Ca+Mg) molar ratio	**SO_4/(Ca+Mg)**				5.8	4.7	5.1	6.3	3.8	6.7	11.7	28.8	26.1	29.9	27.1	16.2	20.8	20.8	19.2	15.1

Notes:

ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. # for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm * Acidity and alkalinity data calculated in mg CaCO3/L. Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent. # for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm ** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.

9.4 Attachment D: ALS raw data

9.4.1 Attachment D1: KLC analysis (Batch Number EB2111789, EB2112269, EB2113044, EB2113873, EB2117702, EB2120583, EB2123336, EB2126300, EB2129176, EB2132389, EB2135901, EB2200252, EB2202795, EB2205849)

CERTIFICATE OF ANALYSIS

Work Order	: **EB2111789**	Page	: 1 of 7
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057_Broadmeadow East	Date Samples Received	: 30-Apr-2021 17:26
Order number	: -	Date Analysis Commenced	: 04-May-2021
C-O-C number	: 22211	Issue Date	: 10-May-2021 15:53
Sampler	: ALAN ROBERTSON		
Site	: 2020057_Broadmeadow East L1		
Quote number	: BN/1234/19		
No. of samples received	: 6		
No. of samples analysed	: 6		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-1	KLC-2	KLC-3	KLC-4	KLC-5
			Sampling date / time	30-Apr-2021 12:17	30-Apr-2021 12:19	30-Apr-2021 12:19	30-Apr-2021 12:19	30-Apr-2021 12:20
Compound	CAS Number	LOR	Unit	EB2111789-001	EB2111789-002	EB2111789-003	EB2111789-004	EB2111789-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.08	8.17	7.84	8.00	8.21
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	1850	1880	1350	1480	760
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	114	119	100	96	61
Total Alkalinity as CaCO3	----	1	mg/L	114	119	100	96	61
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	1	<1	3	3	<1
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	132	135	159	183	35
Silicon as SiO2	14464-46-1	0.1	mg/L	3.4	3.4	3.1	2.9	4.0
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	405	400	476	549	101
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	308	317	83	94	142
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	20	18	48	64	4
Magnesium	7439-95-4	1	mg/L	17	14	19	26	2
Sodium	7440-23-5	1	mg/L	344	358	201	220	146
Potassium	7440-09-7	1	mg/L	9	9	5	5	4
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.03	0.02	0.01	<0.01	0.13
Antimony	7440-36-0	0.001	mg/L	0.011	0.014	<0.001	<0.001	0.005
Arsenic	7440-38-2	0.001	mg/L	0.031	0.034	<0.001	<0.001	0.088
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	0.044	0.061	0.063	0.076	0.069
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	0.0005	0.0005	<0.0001	<0.0001	0.0002
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L	0.002	0.002	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-1	KLC-2	KLC-3	KLC-4	KLC-5
			Sampling date / time	30-Apr-2021 12:17	30-Apr-2021 12:19	30-Apr-2021 12:19	30-Apr-2021 12:19	30-Apr-2021 12:20
Compound	CAS Number	LOR	Unit	EB2111789-001	EB2111789-002	EB2111789-003	EB2111789-004	EB2111789-005
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	**0.001**	<0.001
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.002**	<0.001	<0.001	**0.004**
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L	**0.017**	**0.016**	**0.016**	**0.020**	**0.006**
Manganese	7439-96-5	0.001	mg/L	**0.010**	**0.006**	**0.035**	**0.078**	<0.001
Molybdenum	7439-98-7	0.001	mg/L	**0.969**	**1.11**	**0.044**	**0.047**	**0.384**
Nickel	7440-02-0	0.001	mg/L	**0.001**	<0.001	**0.001**	**0.003**	<0.001
Rubidium	7440-17-7	0.001	mg/L	**0.010**	**0.009**	**0.006**	**0.006**	**0.004**
Selenium	7782-49-2	0.01	mg/L	**0.22**	**0.23**	**0.01**	**0.02**	**0.13**
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	**0.798**	**0.713**	**1.46**	**2.10**	**0.226**
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L	**0.002**	**0.002**	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.034**	<0.005	<0.005	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-33-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.3**	**0.3**	**0.1**	<0.1	**0.3**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**19.4**	**19.6**	**14.2**	**16.0**	**7.33**
ø Total Cations	----	0.01	meq/L	**17.6**	**17.8**	**12.8**	**15.0**	**6.82**
ø Ionic Balance	----	0.01	%	**4.89**	**4.79**	**5.24**	**3.12**	**3.61**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-6	----	----	----	----
			Sampling date / time	30-Apr-2021 12:21	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2111789-006	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.01**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1150**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**81**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**81**	----	----	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**2**	----	----	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	**57**	----	----	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	**4.6**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**162**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**228**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**11**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**4**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**221**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**5**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.05**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	**0.008**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.122**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.054**	----	----	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0003**	----	----	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	----	----	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	----	----	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	----	----	----	----
Caesium	7440-46-2	0.001	mg/L	**0.001**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-6	----	----	----	----
			Sampling date / time	30-Apr-2021 12:21	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2111789-006	--------	--------	--------	--------
				Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.004**	----	----	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	----	----	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	----	----	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Lithium	7439-93-2	0.001	mg/L	**0.009**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.627**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.006**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	**0.22**	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.301**	----	----	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	----	----	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	----	----	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	----	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	----	----	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	----	----	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----
Tungsten	7440-33-7	0.001	mg/L	<0.001	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.4**	----	----	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**11.4**	----	----	----	----
ø Total Cations	----	0.01	meq/L	**10.6**	----	----	----	----
ø Ionic Balance	----	0.01	%	**3.65**	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2112269**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: LABORATORY	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61 7 3552 8616
Project	: 2020057_Broadmeadow East	Date Samples Received	: 06-May-2021 18:27
Order number	: -	Date Analysis Commenced	: 10-May-2021
C-O-C number	: 22426	Issue Date	: 13-May-2021 14:02
Sampler	: ALAN ROBERTSON		
Site	: 2020057_Broadmeadow East		
Quote number	: BN/1234/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	KLC-1	KLC-3	KLC-5	----	----
			Sampling date / time	06-May-2021 12:33	06-May-2021 12:35	06-May-2021 12:35	----	----
				EB2112269-001	EB2112269-002	EB2112269-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.15	7.88	7.69	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	1360	1910	891	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	188	141	91	----	----
Total Alkalinity as CaCO3	----	1	mg/L	188	141	91	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	2	5	3	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	89	235	40	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	3.3	3.9	3.8	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	286	772	123	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	165	108	158	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	11	84	6	----	----
Magnesium	7439-95-4	1	mg/L	10	36	3	----	----
Sodium	7440-23-5	1	mg/L	268	228	176	----	----
Potassium	7440-09-7	1	mg/L	7	7	5	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	<0.01	0.08	----	----
Antimony	7440-36-0	0.001	mg/L	0.017	<0.001	0.006	----	----
Arsenic	7440-38-2	0.001	mg/L	0.037	<0.001	0.068	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L	0.036	0.042	0.092	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	0.0003	<0.0001	0.0002	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-1	KLC-3	KLC-5	----	----
			Sampling date / time	06-May-2021 12:33	06-May-2021 12:35	06-May-2021 12:35	----	----
Compound	CAS Number	LOR	Unit	EB2112269-001	EB2112269-002	EB2112269-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.002**	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	**0.001**	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lithium	7439-93-2	0.001	mg/L	**0.015**	**0.027**	**0.007**	----	----
Manganese	7439-96-5	0.001	mg/L	**0.013**	**0.139**	**0.002**	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.778**	**0.032**	**0.464**	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.005**	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.008**	**0.006**	**0.004**	----	----
Selenium	7782-49-2	0.01	mg/L	**0.11**	**0.02**	**0.16**	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**0.556**	**3.40**	**0.316**	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Uranium	7440-61-1	0.001	mg/L	**0.003**	<0.001	<0.001	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Tungsten	7440-33-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.3**	**0.1**	**0.3**	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2113044**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057_Broadmeadow East	Date Samples Received	: 13-May-2021 15:45
Order number	: -	Date Analysis Commenced	: 16-May-2021
C-O-C number	: 22729	Issue Date	: 21-May-2021 10:53
Sampler	: ALAN ROBERTSON		
Site	: 2020057_Broadmeadow East L3		
Quote number	: BN/1234/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	KLC-1	KLC-3	KLC-5	----	----
Sampling date / time				13-May-2021 10:23	13-May-2021 10:24	13-May-2021 10:25	----	----
				EB2113044-001	EB2113044-002	EB2113044-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.20	7.95	7.96	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	918	1730	720	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	188	142	88	----	----
Total Alkalinity as CaCO3	----	1	mg/L	188	142	88	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	2	4	2	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	----	211	32	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	----	4.1	3.9	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	153	675	102	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	82	94	109	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	6	94	5	----	----
Magnesium	7439-95-4	1	mg/L	6	40	2	----	----
Sodium	7440-23-5	1	mg/L	202	247	144	----	----
Potassium	7440-09-7	1	mg/L	6	6	4	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.03	<0.01	0.11	----	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	0.039	0.002	0.058	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Erbium	7440-52-0	0.001	mg/L	<0.001	----	----	----	----
Boron	7440-42-8	0.05	mg/L	0.14	----	----	----	----
Europium	7440-53-1	0.001	mg/L	<0.001	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	0.316	3.83	0.212	----	----
Barium	7440-39-3	0.001	mg/L	0.031	0.039	0.064	----	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-1	KLC-3	KLC-5	----	----
			Sampling date / time	13-May-2021 10:23	13-May-2021 10:24	13-May-2021 10:25	----	----
Compound	CAS Number	LOR	Unit	EB2113044-001	EB2113044-002	EB2113044-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Gallium	7440-55-3	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0003**	<0.0001	**0.0002**	----	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	----	----	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.002**	<0.001	----	----
Holmium	7440-60-0	0.001	mg/L	<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L	**0.002**	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.006**	**0.006**	**0.003**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.012**	**0.026**	**0.007**	----	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	----	----	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	**0.009**	**0.170**	**0.004**	----	----
Neodymium	7440-00-8	0.001	mg/L	<0.001	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.618**	**0.021**	**0.380**	----	----
Praseodymium	7440-10-0	0.001	mg/L	<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.006**	<0.001	----	----
Samarium	7440-19-9	0.001	mg/L	<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Terbium	7440-27-9	0.001	mg/L	<0.001	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	**0.017**	<0.001	**0.005**	----	----
Thulium	7440-30-4	0.001	mg/L	<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	**0.01**	<0.01	**0.06**	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-1	KLC-3	KLC-5	----	----
			Sampling date / time	13-May-2021 10:23	13-May-2021 10:24	13-May-2021 10:25	----	----
Compound	CAS Number	LOR	Unit	EB2113044-001	EB2113044-002	EB2113044-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Tungsten	7440-33-7	0.001	mg/L	----	<0.001	<0.001	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.3**	<0.1	**0.2**	----	----
EN055: Ionic Balance								
ø **Total Anions**	----	0.01	meq/L	**9.25**	**19.5**	**6.96**	----	----
ø **Total Cations**	----	0.01	meq/L	**9.73**	**18.9**	**6.78**	----	----
ø **Ionic Balance**	----	0.01	%	**2.52**	**1.72**	**1.29**	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2113873**	Page	: 1 of 8
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: LABORATORY	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61 7 3552 8616
Project	: 2020057_Broadmeadow East	Date Samples Received	: 20-May-2021 17:38
Order number	: -	Date Analysis Commenced	: 24-May-2021
C-O-C number	: 23059	Issue Date	: 27-May-2021 17:13
Sampler	: ALAN ROBERTSON		
Site	: 2020057_Broadmeadow East L		
Quote number	: BN/1234/19		
No. of samples received	: 6		
No. of samples analysed	: 6		

NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

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- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-1	KLC-2	KLC-3	KLC-4	KLC-5
			Sampling date / time	20-May-2021 13:05	20-May-2021 13:06	20-May-2021 13:07	20-May-2021 13:07	20-May-2021 13:08
Compound	CAS Number	LOR	Unit	EB2113873-001	EB2113873-002	EB2113873-003	EB2113873-004	EB2113873-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.31	8.21	7.97	7.83	8.02
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	664	1640	1280	2110	531
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	201	125	161	54	96
Total Alkalinity as CaCO3	----	1	mg/L	201	125	161	54	96
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	<1	<1	8	4	2
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	----	128	132	313	22
Silicon as SiO2	14464-46-1	0.1	mg/L	----	2.8	3.9	2.5	3.9
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	84	426	444	969	70
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	41	214	62	92	63
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	6	14	75	118	3
Magnesium	7439-95-4	1	mg/L	4	12	31	46	1
Sodium	7440-23-5	1	mg/L	157	308	187	272	114
Potassium	7440-09-7	1	mg/L	6	8	6	7	3
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.07	0.04	<0.01	<0.01	0.21
Dysprosium	7429-91-6	0.001	mg/L	<0.001	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	0.035	0.023	0.002	<0.001	0.063
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L	<0.001	----	----	----	----
Boron	7440-42-8	0.05	mg/L	0.10	----	----	----	----
Europium	7440-53-1	0.001	mg/L	<0.001	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	0.209	0.657	2.98	4.59	0.136
Barium	7440-39-3	0.001	mg/L	0.037	0.040	0.043	0.041	0.049
Gadolinium	7440-54-2	0.001	mg/L	<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-1	KLC-2	KLC-3	KLC-4	KLC-5
			Sampling date / time	20-May-2021 13:05	20-May-2021 13:06	20-May-2021 13:07	20-May-2021 13:07	20-May-2021 13:08
Compound	CAS Number	LOR	Unit	EB2113873-001	EB2113873-002	EB2113873-003	EB2113873-004	EB2113873-005
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0003**	**0.0002**	<0.0001	<0.0001	**0.0002**
Hafnium	7440-58-6	0.01	mg/L	<0.01	----	----	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	**0.001**	**0.002**	<0.001
Holmium	7440-60-0	0.001	mg/L	<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L	**0.002**	**0.002**	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L	<0.001	**0.001**	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L	**0.004**	**0.009**	**0.005**	**0.006**	**0.002**
Lithium	7439-93-2	0.001	mg/L	**0.009**	**0.016**	**0.023**	**0.024**	**0.006**
Lutetium	7439-94-3	0.001	mg/L	<0.001	----	----	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.009**	**0.005**	**0.147**	**0.068**	**0.003**
Neodymium	7440-00-8	0.001	mg/L	<0.001	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.396**	**0.325**	**0.017**	**0.015**	**0.269**
Praseodymium	7440-10-0	0.001	mg/L	<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	<0.001	**0.004**	**0.005**	**0.002**
Samarium	7440-19-9	0.001	mg/L	<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Terbium	7440-27-9	0.001	mg/L	<0.001	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	**0.013**	**0.011**	<0.001	<0.001	**0.004**
Thulium	7440-30-4	0.001	mg/L	<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	**0.17**	<0.01	**0.03**	**0.02**
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	KLC-1	KLC-2	KLC-3	KLC-4	KLC-5
Sampling date / time				20-May-2021 13:05	20-May-2021 13:06	20-May-2021 13:07	20-May-2021 13:07	20-May-2021 13:08
				EB2113873-001	EB2113873-002	EB2113873-003	EB2113873-004	EB2113873-005
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.11**	<0.05	<0.05
Tungsten	7440-33-7	0.001	mg/L	----	<0.001	<0.001	<0.001	<0.001
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.3**	**0.3**	**0.2**	**0.1**	**0.2**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**6.92**	**17.4**	**14.2**	**23.8**	**5.15**
ø Total Cations	----	0.01	meq/L	**7.61**	**15.3**	**14.6**	**21.7**	**5.27**
ø Ionic Balance	----	0.01	%	**4.74**	**6.47**	**1.29**	**4.75**	**1.10**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-6	----	----	----	----
			Sampling date / time	20-May-2021 13:08	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2113873-006	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.12**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1080**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**81**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**81**	----	----	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	<1	----	----	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	**60**	----	----	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	**4.0**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**192**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**180**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**7**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**3**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**234**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**5**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.10**	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.080**	----	----	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.265**	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.025**	----	----	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0003**	----	----	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-6	----	----	----	----
			Sampling date / time	20-May-2021 13:08	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2113873-006	--------	--------	--------	--------
				Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Uranium	7440-61-1	0.001	mg/L	**0.001**	----	----	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	----	----	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	----	----	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.005**	----	----	----	----
Lithium	7439-93-2	0.001	mg/L	**0.012**	----	----	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	----	----	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.518**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	**0.007**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	**0.26**	----	----	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	----	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	----	----	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	----	----	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	----	----	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----
Tungsten	7440-33-7	0.001	mg/L	<0.001	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.4**	----	----	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**10.7**	----	----	----	----
ø Total Cations	----	0.01	meq/L	**10.9**	----	----	----	----
ø Ionic Balance	----	0.01	%	**0.97**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2117702**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057_Broadmeadow East	Date Samples Received	: 24-Jun-2021 16:33
Order number	:	Date Analysis Commenced	: 26-Jun-2021
C-O-C number	: 24569	Issue Date	: 05-Jul-2021 15:27
Sampler	: ALAN ROBERTSON		
Site	: 2020057_Broadmeadow East L		
Quote number	: BN/1234/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	24-Jun-2021 11:06	24-Jun-2021 11:07	24-Jun-2021 11:07	----	----
Compound	CAS Number	LOR	Unit	EB2117702-001	EB2117702-002	EB2117702-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.18**	**7.80**	**8.06**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1260**	**1790**	**967**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**126**	**59**	**66**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**126**	**59**	**66**	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**1**	**3**	**2**	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	**108**	**283**	**64**	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	**2.2**	**2.2**	**3.4**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**356**	**861**	**205**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**109**	**48**	**106**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**11**	**135**	**4**	----	----
Magnesium	7439-95-4	1	mg/L	**10**	**57**	**2**	----	----
Sodium	7440-23-5	1	mg/L	**260**	**216**	**188**	----	----
Potassium	7440-09-7	1	mg/L	**9**	**6**	**5**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.04**	**0.01**	**0.16**	----	----
Antimony	7440-36-0	0.001	mg/L	**0.009**	<0.001	**0.004**	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.013**	<0.001	**0.030**	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L	**0.048**	**0.035**	**0.054**	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	**0.0001**	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	24-Jun-2021 11:06	24-Jun-2021 11:07	24-Jun-2021 11:07	----	----
Compound	CAS Number	LOR	Unit	EB2117702-001	EB2117702-002	EB2117702-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.002**	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.001**	<0.001	**0.002**	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lithium	7439-93-2	0.001	mg/L	**0.016**	**0.026**	**0.013**	----	----
Manganese	7439-96-5	0.001	mg/L	**0.002**	**0.065**	<0.001	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.165**	**0.012**	**0.376**	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.003**	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.005**	**0.004**	**0.003**	----	----
Selenium	7782-49-2	0.01	mg/L	**0.11**	**0.02**	**0.19**	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**0.450**	**4.39**	**0.224**	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Uranium	7440-61-1	0.001	mg/L	**0.002**	<0.001	<0.001	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Boron	7440-42-8	0.05	mg/L	**0.13**	<0.05	**0.07**	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Tungsten	7440-33-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.3**	**0.1**	**0.3**	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**13.0**	**20.4**	**8.58**	----	----
ø Total Cations	----	0.01	meq/L	**12.9**	**21.0**	**8.67**	----	----
ø Ionic Balance	----	0.01	%	**0.36**	**1.25**	**0.54**	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2120583**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057_Broadmeadow East	Date Samples Received	: 22-Jul-2021 17:26
Order number	: -	Date Analysis Commenced	: 23-Jul-2021
C-O-C number	: 25582	Issue Date	: 29-Jul-2021 14:24
Sampler	: ALAN ROBERTSON		
Site	: 2020057_Broadmeadow East L4		
Quote number	: BN/1234/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Thomas Donovan		Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	22-Jul-2021 12:44	22-Jul-2021 12:45	22-Jul-2021 12:47	----	----
Compound	CAS Number	LOR	Unit	EB2120583-001	EB2120583-002	EB2120583-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.27**	**7.78**	**8.15**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**817**	**1840**	**618**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**128**	**52**	**74**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**128**	**52**	**74**	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	<1	**2**	<1	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	**66**	**305**	----	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	**1.9**	**2.0**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**208**	**924**	**126**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**44**	**45**	**43**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**4**	**111**	**1**	----	----
Magnesium	7439-95-4	1	mg/L	**3**	**39**	<1	----	----
Sodium	7440-23-5	1	mg/L	**106**	**116**	**80**	----	----
Potassium	7440-09-7	1	mg/L	**4**	**4**	**7**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.12**	<0.01	**0.25**	----	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.016**	<0.001	**0.049**	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L	**0.07**	<0.05	**0.05**	----	----
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**0.150**	**3.60**	**0.056**	----	----
Barium	7440-39-3	0.001	mg/L	**0.013**	**0.020**	**0.013**	----	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	22-Jul-2021 12:44	22-Jul-2021 12:45	22-Jul-2021 12:47	----	----
Compound	CAS Number	LOR	Unit	EB2120583-001	EB2120583-002	EB2120583-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.001**	<0.001	----	----
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.001**	<0.001	**0.002**	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.002**	**0.003**	**0.001**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.006**	**0.020**	**0.005**	----	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	**0.047**	<0.001	----	----
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.059**	**0.006**	**0.134**	----	----
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.004**	<0.001	----	----
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Antimony	7440-36-0	0.001	mg/L	**0.008**	<0.001	**0.004**	----	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	**0.04**	**0.01**	**0.06**	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	22-Jul-2021 12:44	22-Jul-2021 12:45	22-Jul-2021 12:47	----	----
Compound	CAS Number	LOR	Unit	EB2120583-001	EB2120583-002	EB2120583-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.007**	<0.005	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Tungsten	7440-33-7	0.001	mg/L	<0.001	<0.001	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	<0.1	**0.2**	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**3**	<1	**4**	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2123336**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL PTY LTD - DO NOT USE**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057_Broadmeadow East	Date Samples Received	: 19-Aug-2021 16:12
Order number	:	Date Analysis Commenced	: 20-Aug-2021
C-O-C number	: 26597	Issue Date	: 25-Aug-2021 15:26
Sampler	: ALAN ROBERTSON, RGS LABORATORY		
Site	: 2020057_Broadmeadow East L5		
Quote number	: BN/1234/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Thomas Donovan	Senior Organic Chemist - PFAS	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the Chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- EP005: Result for sample 'KLC-6' may bias low due to large amounts of sediment. The sample was decanted before analysis.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	19-Aug-2021 11:20	19-Aug-2021 11:21	19-Aug-2021 11:21	----	----
Compound	CAS Number	LOR	Unit	EB2123336-001	EB2123336-002	EB2123336-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.40	7.88	8.21	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	709	1550	537	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	4	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	127	52	76	----	----
Total Alkalinity as CaCO3	----	1	mg/L	131	52	76	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	<1	3	<1	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	52	236	38	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	2.0	1.8	3.5	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	163	746	114	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	21	27	22	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	4	118	1	----	----
Magnesium	7439-95-4	1	mg/L	3	42	<1	----	----
Sodium	7440-23-5	1	mg/L	106	99	79	----	----
Potassium	7440-09-7	1	mg/L	4	4	2	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.18	<0.01	0.33	----	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	0.014	<0.001	0.040	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L	0.07	<0.05	<0.05	----	----
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	0.159	3.76	0.056	----	----
Barium	7440-39-3	0.001	mg/L	0.021	0.028	0.019	----	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	19-Aug-2021 11:20	19-Aug-2021 11:21	19-Aug-2021 11:21	----	----
Compound	CAS Number	LOR	Unit	EB2123336-001	EB2123336-002	EB2123336-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L	**0.001**	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.001**	<0.001	**0.001**	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.003**	**0.004**	**0.002**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.008**	**0.023**	**0.006**	----	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	**0.017**	<0.001	----	----
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.068**	**0.005**	**0.176**	----	----
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.004**	<0.001	----	----
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Antimony	7440-36-0	0.001	mg/L	**0.007**	<0.001	**0.004**	----	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	**0.03**	<0.01	**0.06**	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	19-Aug-2021 11:20	19-Aug-2021 11:21	19-Aug-2021 11:21	----	----
Compound	CAS Number	LOR	Unit	EB2123336-001	EB2123336-002	EB2123336-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.006**	<0.005	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Tungsten	7440-33-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.3**	<0.1	**0.2**	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**4**	**3**	**3**	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2126300**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057_Broadmeadow East	Date Samples Received	: 16-Sep-2021 15:53
Order number	: -	Date Analysis Commenced	: 17-Sep-2021
C-O-C number	: 27731	Issue Date	: 23-Sep-2021 16:55
Sampler	: ALAN ROBERTSON		
Site	: 2020057_Broadmeadow East L6		
Quote number	: BN/1234/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Thomas Donovan	Senior Organic Chemist - PFAS	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	16-Sep-2021 13:07	16-Sep-2021 13:07	16-Sep-2021 13:08	----	----
Compound	CAS Number	LOR	Unit	EB2126300-001	EB2126300-002	EB2126300-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.50	8.00	8.24	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	602	1530	414	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	7	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	134	58	80	----	----
Total Alkalinity as CaCO3	----	1	mg/L	141	58	80	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	<1	5	<1	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	46	257	31	----	----
Silicon as SiO2	14464-46-1	0.1	mg/L	2.0	1.9	3.7	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	137	799	95	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	10	14	11	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	4	97	<1	----	----
Magnesium	7439-95-4	1	mg/L	3	39	<1	----	----
Sodium	7440-23-5	1	mg/L	100	66	66	----	----
Potassium	7440-09-7	1	mg/L	11	4	4	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.15	<0.01	0.40	----	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	0.012	<0.001	0.048	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L	0.08	<0.05	0.06	----	----
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	0.166	3.25	0.043	----	----
Barium	7440-39-3	0.001	mg/L	0.024	0.023	0.014	----	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	16-Sep-2021 13:07	16-Sep-2021 13:07	16-Sep-2021 13:08	----	----
Compound	CAS Number	LOR	Unit	EB2126300-001	EB2126300-002	EB2126300-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	<0.001	**0.005**	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.004**	**0.003**	**0.002**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.007**	**0.010**	**0.005**	----	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	**0.001**	**0.003**	<0.001	----	----
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.058**	**0.004**	**0.154**	----	----
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.003**	<0.001	----	----
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Antimony	7440-36-0	0.001	mg/L	**0.006**	<0.001	**0.004**	----	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	**0.03**	**0.01**	**0.04**	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	16-Sep-2021 13:07	16-Sep-2021 13:07	16-Sep-2021 13:08	----	----
Compound	CAS Number	LOR	Unit	EB2126300-001	EB2126300-002	EB2126300-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.013**	<0.005	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.06**	----	----
Tungsten	7440-33-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.3**	<0.1	**0.2**	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**3**	**2**	**2**	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2129176**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057 Broadmeadow East	Date Samples Received	: 14-Oct-2021 15:05
Order number	:	Date Analysis Commenced	: 16-Oct-2021
C-O-C number	: 28768	Issue Date	: 21-Oct-2021 13:24
Sampler	: ALAN ROBERTSON		
Site	: 2020057 Broadmeadow East L		
Quote number	: BN/1234/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Thomas Donovan	Senior Organic Chemist - PFAS	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Ionic Balance out of acceptable limits due to analytes not quantified in this report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	14-Oct-2021 11:48	14-Oct-2021 11:49	14-Oct-2021 11:50	----	----
Compound	CAS Number	LOR	Unit	EB2129176-001	EB2129176-002	EB2129176-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.25**	**7.77**	**8.13**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**612**	**1300**	**391**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**146**	**58**	**89**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**146**	**58**	**89**	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	<1	**7**	<1	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**139**	**670**	**86**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**7**	**7**	**6**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**4**	**98**	<1	----	----
Magnesium	7439-95-4	1	mg/L	**3**	**38**	<1	----	----
Sodium	7440-23-5	1	mg/L	**85**	**43**	**55**	----	----
Potassium	7440-09-7	1	mg/L	**4**	**4**	**2**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.22**	<0.01	**0.98**	----	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.008**	<0.001	**0.052**	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L	**0.08**	<0.05	<0.05	----	----
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**0.156**	**2.88**	**0.040**	----	----
Barium	7440-39-3	0.001	mg/L	**0.022**	**0.022**	**0.016**	----	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	**0.03**	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	14-Oct-2021 11:48	14-Oct-2021 11:49	14-Oct-2021 11:50	----	----
Compound	CAS Number	LOR	Unit	EB2129176-001	EB2129176-002	EB2129176-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.004**	<0.001	**0.005**	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.003**	**0.003**	**0.002**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.008**	**0.020**	**0.005**	----	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	**0.002**	**0.002**	<0.001	----	----
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.052**	**0.002**	**0.128**	----	----
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.003**	<0.001	----	----
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Antimony	7440-36-0	0.001	mg/L	**0.006**	<0.001	**0.004**	----	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	**0.02**	<0.01	**0.03**	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.007**	<0.005	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.12**	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Sample ID	**KLC-2**	**KLC-4**	**KLC-6**	**----**	**----**
			Sampling date / time	14-Oct-2021 11:48	14-Oct-2021 11:49	14-Oct-2021 11:50	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2129176-001**	**EB2129176-002**	**EB2129176-003**	**--------**	**--------**
				Result	Result	Result	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.3**	**0.2**	**0.2**	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**2**	<1	**1**	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2132389**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057 Broadmeadow East	Date Samples Received	: 11-Nov-2021 15:35
Order number	:	Date Analysis Commenced	: 14-Nov-2021
C-O-C number	: 28752	Issue Date	: 19-Nov-2021 17:46
Sampler	: ALAN ROBERTSON, RGS LABORATORY		
Site	: 2020057 Broadmeadow East L8		
Quote number	: BN/1234/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Dave Gitsham	Metals Instrument Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Thomas Donovan	Senior Organic Chemist - PFAS	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	11-Nov-2021 11:30	11-Nov-2021 11:39	11-Nov-2021 11:40	----	----
Compound	CAS Number	LOR	Unit	EB2132389-001	EB2132389-002	EB2132389-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.40**	**7.92**	**8.17**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**586**	**1260**	**363**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	**17**	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**145**	**86**	**81**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**162**	**86**	**81**	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	<1	**5**	**2**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**114**	**615**	**71**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**4**	**4**	**3**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**6**	**137**	**1**	----	----
Magnesium	7439-95-4	1	mg/L	**4**	**52**	<1	----	----
Sodium	7440-23-5	1	mg/L	**112**	**52**	**69**	----	----
Potassium	7440-09-7	1	mg/L	**4**	**4**	**2**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.10**	**0.02**	**0.26**	----	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.005**	<0.001	**0.040**	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L	**0.06**	<0.05	<0.05	----	----
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**0.308**	**3.90**	**0.070**	----	----
Barium	7440-39-3	0.001	mg/L	**0.039**	**0.029**	**0.026**	----	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	11-Nov-2021 11:30	11-Nov-2021 11:39	11-Nov-2021 11:40	----	----
Compound	CAS Number	LOR	Unit	EB2132389-001	EB2132389-002	EB2132389-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L	**0.001**	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	**0.005**	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.003**	**0.004**	**0.001**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.010**	**0.031**	**0.005**	----	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.047**	**0.004**	**0.144**	----	----
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.003**	<0.001	----	----
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Antimony	7440-36-0	0.001	mg/L	**0.007**	<0.001	**0.007**	----	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	**0.01**	**0.02**	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC-2	KLC-4	KLC-6	----	----
			Sampling date / time	11-Nov-2021 11:30	11-Nov-2021 11:39	11-Nov-2021 11:40	----	----
Compound	CAS Number	LOR	Unit	EB2132389-001	EB2132389-002	EB2132389-003	--------	--------
				Result	Result	Result	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	**0.1**	**0.2**	----	----
EN055: Ionic Balance								
ø **Total Anions**	----	0.01	meq/L	**5.72**	**14.6**	**3.18**	----	----
ø **Total Cations**	----	0.01	meq/L	**5.60**	**13.5**	**3.10**	----	----
ø **Ionic Balance**	----	0.01	%	**1.06**	**4.11**	**1.26**	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	<1	<1	**1**	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2135901**	Page	: 1 of 5
Amendment	: **1**		
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: GREG MADDOCKS	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057 Broadmeadow East	Date Samples Received	: 09-Dec-2021 16:49
Order number	: ----	Date Analysis Commenced	: 15-Dec-2021
C-O-C number	: ----	Issue Date	: 23-Dec-2021 10:19
Sampler	: ALEXANDRA KISS		
Site	: ----		
Quote number	: BN/1234/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Dave Gitsham	Metals Instrument Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Ionic Balance out of acceptable limits due to analytes not quantified in this report.
- Amendment (21/12/21): This report has been amended and re-released to allow the reporting of the ionic balance.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC 2	KLC 4	KLC 6	----	----
			Sampling date / time	09-Dec-2021 00:00	09-Dec-2021 00:00	09-Dec-2021 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2135901-001	EB2135901-002	EB2135901-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.37**	**7.69**	**8.12**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**510**	**1090**	**308**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**156**	**61**	**87**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**156**	**61**	**87**	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	<1	**3**	<1	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**107**	**565**	**66**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3**	**2**	**2**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**4**	**116**	<1	----	----
Magnesium	7439-95-4	1	mg/L	**4**	**40**	<1	----	----
Sodium	7440-23-5	1	mg/L	**79**	**24**	**51**	----	----
Potassium	7440-09-7	1	mg/L	**4**	**3**	**2**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.10**	<0.01	**0.44**	----	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.005**	<0.001	**0.034**	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L	**0.08**	<0.05	**0.06**	----	----
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**0.164**	**3.01**	**0.031**	----	----
Barium	7440-39-3	0.001	mg/L	**0.020**	**0.033**	**0.014**	----	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	**0.01**	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC 2	KLC 4	KLC 6	----	----
			Sampling date / time	09-Dec-2021 00:00	09-Dec-2021 00:00	09-Dec-2021 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2135901-001	EB2135901-002	EB2135901-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.001**	<0.001	**0.005**	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.003**	**0.003**	**0.001**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.010**	**0.025**	**0.006**	----	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	**0.002**	<0.001	----	----
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.031**	**0.002**	**0.096**	----	----
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.002**	<0.001	----	----
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Antimony	7440-36-0	0.001	mg/L	**0.003**	<0.001	**0.003**	----	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	**0.01**	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.011**	<0.005	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.06**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC 2	KLC 4	KLC 6	----	----
			Sampling date / time	09-Dec-2021 00:00	09-Dec-2021 00:00	09-Dec-2021 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2135901-001	EB2135901-002	EB2135901-003	--------	--------
				Result	Result	Result	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	<0.1	**0.1**	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**5.43**	**13.0**	**3.17**	----	----
ø Total Cations	----	0.01	meq/L	**4.07**	**10.2**	**2.27**	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2200252**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: GREG MADDOCKS	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057 Broadmeadow East	Date Samples Received	: 06-Jan-2022 16:09
Order number	: ----	Date Analysis Commenced	: 07-Jan-2022
C-O-C number	: ----	Issue Date	: 13-Jan-2022 14:01
Sampler	: ALEXANDRA KISS		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Ionic Balance out of acceptable limits due to analytes not quantified in this report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC 2	KLC 4	KLC 6	----	----
			Sampling date / time	06-Jan-2022 00:00	06-Jan-2022 00:00	06-Jan-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2200252-001	EB2200252-002	EB2200252-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.15**	**7.42**	**8.07**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**502**	**1170**	**310**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**145**	**58**	**85**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**145**	**58**	**85**	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**4**	**6**	<1	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**109**	**622**	**66**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3**	**3**	**1**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**5**	**121**	<1	----	----
Magnesium	7439-95-4	1	mg/L	**5**	**44**	<1	----	----
Sodium	7440-23-5	1	mg/L	**80**	**20**	**58**	----	----
Potassium	7440-09-7	1	mg/L	**5**	**3**	**3**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.08**	**0.01**	**0.97**	----	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.004**	<0.001	**0.034**	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L	**0.07**	<0.05	**0.07**	----	----
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**0.206**	**2.81**	**0.041**	----	----
Barium	7440-39-3	0.001	mg/L	**0.026**	**0.021**	**0.019**	----	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	**0.03**	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC 2	KLC 4	KLC 6	----	----
			Sampling date / time	06-Jan-2022 00:00	06-Jan-2022 00:00	06-Jan-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2200252-001	EB2200252-002	EB2200252-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	<0.001	**0.004**	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.003**	**0.002**	**0.002**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.009**	**0.022**	**0.006**	----	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	**0.001**	<0.001	----	----
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.027**	**0.002**	**0.088**	----	----
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.002**	<0.001	----	----
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Antimony	7440-36-0	0.001	mg/L	**0.003**	<0.001	**0.004**	----	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	**0.01**	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.008**	<0.005	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.11**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC 2	KLC 4	KLC 6	----	----
			Sampling date / time	06-Jan-2022 00:00	06-Jan-2022 00:00	06-Jan-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2200252-001	EB2200252-002	EB2200252-003	--------	--------
				Result	Result	Result	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	**0.1**	**0.2**	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**5.25**	**14.2**	**3.10**	----	----
ø Total Cations	----	0.01	meq/L	**4.27**	**10.6**	**2.60**	----	----
ø Ionic Balance	----	0.01	%	**10.3**	**14.5**	**8.79**	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2202795**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: GREG MADDOCKS	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057 Broadmeadow East	Date Samples Received	: 03-Feb-2022 15:48
Order number	: ----	Date Analysis Commenced	: 04-Feb-2022
C-O-C number	: ----	Issue Date	: 11-Feb-2022 09:44
Sampler	: ALEXANDRA KISS		
Site	: ----		
Quote number	: BN/1234/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Ionic Balance out of acceptable limits due to analytes not quantified in this report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC 2	KLC 4	KLC 6	----	----
			Sampling date / time	03-Feb-2022 00:00	03-Feb-2022 00:00	03-Feb-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2202795-001	EB2202795-002	EB2202795-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.25**	**7.17**	**8.13**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**508**	**1160**	**301**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**139**	**54**	**83**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**139**	**54**	**83**	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**1**	**8**	<1	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**108**	**610**	**61**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**2**	**2**	**1**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**6**	**122**	<1	----	----
Magnesium	7439-95-4	1	mg/L	**5**	**42**	<1	----	----
Sodium	7440-23-5	1	mg/L	**72**	**13**	**46**	----	----
Potassium	7440-09-7	1	mg/L	**4**	**2**	**1**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.12**	<0.01	**0.24**	----	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.003**	<0.001	**0.027**	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L	**0.07**	<0.05	**0.06**	----	----
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**0.224**	**2.74**	**0.031**	----	----
Barium	7440-39-3	0.001	mg/L	**0.028**	**0.022**	**0.012**	----	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC 2	KLC 4	KLC 6	----	----
			Sampling date / time	03-Feb-2022 00:00	03-Feb-2022 00:00	03-Feb-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2202795-001	EB2202795-002	EB2202795-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	**0.004**	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.003**	**0.002**	**0.001**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.011**	**0.027**	**0.006**	----	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.024**	**0.001**	**0.065**	----	----
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.001**	<0.001	----	----
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Antimony	7440-36-0	0.001	mg/L	**0.002**	<0.001	**0.003**	----	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.008**	<0.005	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	KLC 2	KLC 4	KLC 6	----	----
			Sampling date / time	03-Feb-2022 00:00	03-Feb-2022 00:00	03-Feb-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2202795-001	EB2202795-002	EB2202795-003	--------	--------
				Result	Result	Result	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	**0.1**	**0.2**	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**5.08**	**13.8**	**2.96**	----	----
ø Total Cations	----	0.01	meq/L	**3.94**	**10.2**	**2.03**	----	----
ø Ionic Balance	----	0.01	%	**12.6**	**15.3**	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2205849**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: GREG MADDOCKS	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057 Broadmeadow East	Date Samples Received	: 03-Mar-2022 14:05
Order number	: ----	Date Analysis Commenced	: 08-Mar-2022
C-O-C number	: ----	Issue Date	: 11-Mar-2022 09:45
Sampler	: LEXI KNG		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

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Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC 2	WKLC 4	WKLC 6	----	----
			Sampling date / time	03-Mar-2022 00:00	03-Mar-2022 00:00	03-Mar-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2205849-001	EB2205849-002	EB2205849-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.09**	**7.46**	**8.08**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**419**	**1010**	**251**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**107**	**48**	**65**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**107**	**48**	**65**	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	<1	**3**	<1	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**89**	**526**	**48**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3**	**2**	<1	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**7**	**130**	<1	----	----
Magnesium	7439-95-4	1	mg/L	**6**	**50**	<1	----	----
Sodium	7440-23-5	1	mg/L	**70**	**13**	**52**	----	----
Potassium	7440-09-7	1	mg/L	**4**	**3**	**2**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.10**	**0.01**	**1.25**	----	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.003**	<0.001	**0.032**	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L	**0.08**	<0.05	**0.08**	----	----
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**0.299**	**3.25**	**0.054**	----	----
Barium	7440-39-3	0.001	mg/L	**0.034**	**0.034**	**0.022**	----	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	**0.04**	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC 2	WKLC 4	WKLC 6	----	----
			Sampling date / time	03-Mar-2022 00:00	03-Mar-2022 00:00	03-Mar-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2205849-001	EB2205849-002	EB2205849-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.003**	**0.006**	----	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L	**0.004**	**0.002**	**0.003**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.014**	**0.030**	**0.007**	----	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.018**	**0.001**	**0.068**	----	----
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.002**	<0.001	----	----
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Antimony	7440-36-0	0.001	mg/L	**0.002**	<0.001	**0.005**	----	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	**0.01**	<0.01	<0.01	----	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.010**	<0.005	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.15**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			*Sample ID*	WKLC 2	WKLC 4	WKLC 6	----	----
			Sampling date / time	03-Mar-2022 00:00	03-Mar-2022 00:00	03-Mar-2022 00:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2205849-001**	**EB2205849-002**	**EB2205849-003**	--------	--------
				Result	Result	Result	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	**0.1**	**0.1**	----	----
EN055: Ionic Balance								
ø **Total Anions**	----	0.01	meq/L	**4.08**	**12.0**	**2.30**	----	----
ø **Total Cations**	----	0.01	meq/L	**3.99**	**11.2**	**2.31**	----	----
ø **Ionic Balance**	----	0.01	%	**1.06**	**3.11**	----	----	----

9.4.2 Attachment D2: Drill hole ABA (Batch Number EB2109813)

CERTIFICATE OF ANALYSIS

Work Order	: **EB2109813**	Page	: 1 of 17
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR GREG MADDOCKS	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057 Broadmeadow East	Date Samples Received	: 12-Apr-2021 17:27
Order number	: ----	Date Analysis Commenced	: 20-Apr-2021
C-O-C number	: ----	Issue Date	: 23-Apr-2021 12:45
Sampler	: ALEXANDRA KISS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 74		
No. of samples analysed	: 74		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1001	2020057_C1002	2020057_C1003	2020057_C1004	2020057_C1005
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109813-001	EB2109813-002	EB2109813-003	EB2109813-004	EB2109813-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.4**	**9.2**	**8.9**	**8.9**	**9.0**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-16.1**	**-50.8**	**-51.3**	**-57.5**	**-90.2**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**453**	**572**	**762**	**727**	**601**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**16.4**	**50.8**	**51.3**	**57.5**	**90.2**
ANC as CaCO3	----	0.1	% CaCO3	**1.7**	**5.2**	**5.2**	**5.9**	**9.2**
Fizz Rating	----	0	Fizz Unit	**1**	**2**	**2**	**2**	**2**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.01**	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1006	2020057_C1007	2020057_C1008	2020057_C1009	2020057_C1010
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109813-006	EB2109813-007	EB2109813-008	EB2109813-009	EB2109813-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.9	9.0	9.2	7.6	7.9
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-40.1	-151	-17.7	-9.3	-14.6
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	565	404	419	303	466
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	41.0	152	18.9	9.3	14.9
ANC as CaCO3	----	0.1	% CaCO3	4.2	15.5	1.9	1.0	1.5
Fizz Rating	----	0	Fizz Unit	2	3	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.02	0.04	<0.01	0.01

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1011	2020057_C1012	2020057_C1013	2020057_C1014	2020057_C1015
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109813-011	EB2109813-012	EB2109813-013	EB2109813-014	EB2109813-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.5**	**8.9**	**8.7**	**8.8**	**8.6**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-17.4**	**-82.0**	**-65.9**	**-35.7**	**-91.7**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**561**	**591**	**718**	**727**	**612**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**17.7**	**82.3**	**65.9**	**35.7**	**91.7**
ANC as CaCO3	----	0.1	% CaCO3	**1.8**	**8.4**	**6.7**	**3.6**	**9.4**
Fizz Rating	----	0	Fizz Unit	**1**	**2**	**2**	**2**	**2**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.01**	**0.01**	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	2020057_C1016	2020057_C1017	2020057_C1018	2020057_C1019	2020057_C1020
Sampling date / time				12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
				EB2109813-016	EB2109813-017	EB2109813-018	EB2109813-019	EB2109813-020
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.6	8.8	8.8	8.7	8.4
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-40.5	-254	-36.4	-31.3	-12.3
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	509	456	622	566	553
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	40.5	254	37.0	32.8	23.0
ANC as CaCO3	----	0.1	% CaCO3	4.1	25.9	3.8	3.3	2.4
Fizz Rating	----	0	Fizz Unit	2	3	2	2	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	0.02	0.05	0.35

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1021	2020057_C1022	2020057_C1023	2020057_C1024	2020057_C1025
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109813-021	EB2109813-022	EB2109813-023	EB2109813-024	EB2109813-025
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.8**	**7.1**	**8.3**	**8.4**	**8.4**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-14.3**	**-11.8**	**-70.0**	**-110**	**-73.4**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**513**	**272**	**274**	**243**	**328**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**15.8**	**12.1**	**70.0**	**110**	**73.4**
ANC as CaCO3	----	0.1	% CaCO3	**1.6**	**1.2**	**7.1**	**11.3**	**7.5**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**2**	**2**	**2**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.05**	**0.01**	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1026	2020057_C1027	2020057_C1028	2020057_C1029	2020057_C1030
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109813-026	EB2109813-027	EB2109813-028	EB2109813-029	EB2109813-030
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.4	8.4	8.6	8.6	8.4
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-117	-57.2	-31.6	-25.1	-34.7
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	413	514	376	379	535
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	117	57.2	32.2	28.8	38.7
ANC as CaCO3	----	0.1	% CaCO3	12.0	5.8	3.3	2.9	3.9
Fizz Rating	----	0	Fizz Unit	2	2	2	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	0.02	0.12	0.13

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1031	2020057_C1032	2020057_C1033	2020057_C1034	2020057_C1035
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109813-031	EB2109813-032	EB2109813-033	EB2109813-034	EB2109813-035
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.4	8.0	8.5	8.2	7.9
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-5.5	-7.3	-30.6	-7.8	-6.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	284	340	638	589	730
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	5.8	7.6	31.2	8.1	6.6
ANC as CaCO3	----	0.1	% CaCO3	0.6	0.8	3.2	0.8	0.7
Fizz Rating	----	0	Fizz Unit	1	1	2	1	0
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.01	0.02	0.01	0.02

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1036	2020057_C1037	2020057_C1038	2020057_C1039	2020057_C1040
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109813-036	EB2109813-037	EB2109813-038	EB2109813-039	EB2109813-040
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.7	8.7	8.9	9.0	8.8
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-28.6	-31.6	-65.6	-42.4	-26.6
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	682	690	536	408	390
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	29.2	34.0	65.9	43.0	27.5
ANC as CaCO3	----	0.1	% CaCO3	3.0	3.5	6.7	4.4	2.8
Fizz Rating	----	0	Fizz Unit	1	2	2	2	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.08	0.01	0.02	0.03

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1041	2020057_C1042	2020057_C1043	2020057_C1044	2020057_C1045
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109813-041	EB2109813-042	EB2109813-043	EB2109813-044	EB2109813-045
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.7	8.6	7.5	8.3	8.1
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-13.2	-11.4	-4.2	-16.6	-3.7
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	387	311	231	426	197
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	16.3	13.8	4.8	16.9	4.6
ANC as CaCO3	----	0.1	% CaCO3	1.6	1.4	0.5	1.7	0.5
Fizz Rating	----	0	Fizz Unit	1	1	0	1	0
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.10	0.08	0.02	0.01	0.03

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Compound	CAS Number	LOR	Unit	2020057_C1046	2020057_C1047	2020057_C1048	2020057_C1049	2020057_C1050
Sampling date / time				12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
				EB2109813-046	EB2109813-047	EB2109813-048	EB2109813-049	EB2109813-050
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.0	8.2	8.5	8.6	8.7
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-5.8	-5.7	-22.1	-61.1	-70.3
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	358	392	538	334	335
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	6.1	6.0	22.1	61.1	71.5
ANC as CaCO3	----	0.1	% CaCO3	0.6	0.6	2.2	6.2	7.3
Fizz Rating	----	0	Fizz Unit	0	1	1	2	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.01	<0.01	<0.01	0.04

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	2020057_C1051	2020057_C1052	2020057_C1053	2020057_C1054	2020057_C1055
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
				EB2109813-051	EB2109813-052	EB2109813-053	EB2109813-054	EB2109813-055
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.8	8.8	9.0	8.5	8.4
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-33.8	-45.8	-57.4	-60.4	-17.3
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	357	369	362	330	375
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	34.7	46.7	58.0	61.0	22.2
ANC as CaCO3	----	0.1	% CaCO3	3.5	4.8	5.9	6.2	2.3
Fizz Rating	----	0	Fizz Unit	2	2	2	2	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.03	0.02	0.02	0.16

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1056	2020057_C1057	2020057_C1058	2020057_C1059	2020057_C1060
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109813-056	EB2109813-057	EB2109813-058	EB2109813-059	EB2109813-060
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.4	6.9	7.8	8.5	8.1
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-17.3	27.5	0.6	-12.6	-7.9
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	437	1210	817	363	569
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	21.0	19.0	16.2	17.8	22.9
ANC as CaCO3	----	0.1	% CaCO3	2.1	1.9	1.6	1.8	2.3
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.12	1.52	0.55	0.17	0.49

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1061	2020057_C1062	2020057_C1063	2020057_C1064	2020057_C1065
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109813-061	EB2109813-062	EB2109813-063	EB2109813-064	EB2109813-065
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.4	5.9	6.0	5.8	5.9
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-2.2	-1.0	-1.2	-0.9	-1.2
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	98	73	72	124	81
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	2.8	1.9	1.5	1.5	1.5
ANC as CaCO3	----	0.1	% CaCO3	0.3	0.2	0.2	0.2	0.2
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.03	0.01	0.02	0.01

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1066	2020057_C1067	2020057_C1068	2020057_C1069	2020057_C1070
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109813-066	EB2109813-067	EB2109813-068	EB2109813-069	EB2109813-070
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.0	8.0	8.3	8.3	8.5
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-2.6	-31.3	-45.1	-35.4	-55.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	172	336	234	329	294
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	3.2	31.9	46.0	37.8	56.7
ANC as CaCO3	----	0.1	% CaCO3	0.3	3.2	4.7	3.8	5.8
Fizz Rating	----	0	Fizz Unit	0	2	2	2	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.03	0.08	0.03

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

			Sample ID	2020057_C1071	2020057_C1072	2020057_C1073	pH and EC of DI water	----
			Sampling date / time	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	12-Apr-2021 00:00	----
Compound	*CAS Number*	*LOR*	*Unit*	EB2109813-071	EB2109813-072	EB2109813-073	EB2109813-074	--------
				Result	Result	Result	Result	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.3**	**7.8**	**7.7**	**5.9**	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-19.6**	**-6.0**	**16.6**	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**342**	**532**	**1100**	<1	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**23.3**	**16.4**	**37.0**	----	----
ANC as CaCO3	----	0.1	% CaCO3	**2.4**	**1.7**	**3.8**	----	----
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**1**	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.12**	**0.34**	**1.75**	----	----

9.4.3 Attachment D3: Coal quality ABA, CRS (Batch Number EB2107418)

CERTIFICATE OF ANALYSIS

Work Order	: **EB2107418**	Page	: 1 of 10
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR GREG MADDOCKS	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057 Broadmeadow East	Date Samples Received	: 19-Mar-2021 14:05
Order number	: ----	Date Analysis Commenced	: 24-Mar-2021
C-O-C number	: ----	Issue Date	: 26-Mar-2021 13:18
Sampler	: ALEXANDRA KISS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 33		
No. of samples analysed	: 33		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_3001	2020057_3002	2020057_3003	2020057_3004	2020057_3005
			Sampling date / time	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	EB2107418-001	EB2107418-002	EB2107418-003	EB2107418-004	EB2107418-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.3	8.9	9.1	8.4	8.3
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-13.4	-64.1	-32.2	-24.6	<0.5
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	486	418	606	395	357
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	19.2	75.4	38.3	32.6	11.8
ANC as CaCO3	----	0.1	% CaCO3	2.0	7.7	3.9	3.3	1.2
Fizz Rating	----	0	Fizz Unit	1	2	2	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	0.134	0.240	0.169	0.092	0.125
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.19	0.37	0.20	0.26	0.40

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_3006	2020057_3008	2020057_3009	2020057_3010	2020057_3011
			Sampling date / time	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2107418-006	EB2107418-008	EB2107418-009	EB2107418-010	EB2107418-011
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.0	9.0	9.0	8.7	8.6
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-264	-10.2	-22.5	-26.8	-5.5
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	414	440	486	218	308
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	266	18.8	28.3	35.7	17.4
ANC as CaCO3	----	0.1	% CaCO3	27.1	1.9	2.9	3.6	1.8
Fizz Rating	----	0	Fizz Unit	3	1	1	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	0.047	0.182	0.075	0.058	0.102
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.07	0.28	0.19	0.29	0.39

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_3012	2020057_3013	2020057_3014	2020057_3015	2020057_3016
			Sampling date / time	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2107418-012	EB2107418-013	EB2107418-014	EB2107418-015	EB2107418-016
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.1	9.3	9.2	9.0	8.9
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-4.7	-90.2	-72.9	-20.8	-158
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	433	333	307	348	395
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	8.4	91.1	76.6	28.4	167
ANC as CaCO3	----	0.1	% CaCO3	0.8	9.3	7.8	2.9	17.1
Fizz Rating	----	0	Fizz Unit	1	2	2	1	3
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	0.034	0.025	0.040	0.186	0.176
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.12	0.03	0.12	0.25	0.28

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_3017	2020057_3018	2020057_3019	2020057_3020	2020057_3021
			Sampling date / time	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2107418-017	EB2107418-018	EB2107418-019	EB2107418-020	EB2107418-021
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.1	7.4	7.9	8.9	8.9
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-15.7	39.1	16.5	-82.4	-79.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	368	1010	698	811	561
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	30.1	23.6	53.9	109	112
ANC as CaCO3	----	0.1	% CaCO3	3.1	2.4	5.5	11.2	11.4
Fizz Rating	----	0	Fizz Unit	1	1	2	3	3
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	0.248	1.60	1.68	0.745	0.891
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.47	2.05	2.30	0.87	1.08

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_3022	2020057_3023	2020057_3024	2020057_3025	2020057_3026
			Sampling date / time	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2107418-022	EB2107418-023	EB2107418-024	EB2107418-025	EB2107418-026
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.4	8.8	8.2	9.1	6.6
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-12.2	-20.0	6.5	-8.3	22.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	256	137	78	192	478
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	13.4	28.6	2.7	9.5	7.4
ANC as CaCO3	----	0.1	% CaCO3	1.4	2.9	0.3	1.0	0.8
Fizz Rating	----	0	Fizz Unit	1	1	0	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	0.031	0.015	0.014	0.017	0.587
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.28	0.30	0.04	0.96

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_3027	2020057_3028	2020057_3029	2020057_3030	2020057_3031
			Sampling date / time	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00	18-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2107418-027	EB2107418-028	EB2107418-029	EB2107418-030	EB2107418-031
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.9	8.1	7.7	7.8	8.6
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	17.8	-11.4	4.2	12.0	-7.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	336	236	486	349	176
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	6.7	19.7	20.9	11.2	14.2
ANC as CaCO3	----	0.1	% CaCO3	0.7	2.0	2.1	1.1	1.4
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	0.458	0.189	0.449	0.393	0.171
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.80	0.27	0.82	0.76	0.21

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_3032	2020057_3033	----	----	----
			Sampling date / time	18-Mar-2021 00:00	18-Mar-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2107418-032	EB2107418-033	--------	--------	--------
				Result	Result	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.4	9.0	----	----	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-140	-3.0	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	383	429	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	150	10.0	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	15.3	1.0	----	----	----
Fizz Rating	----	0	Fizz Unit	3	1	----	----	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	0.237	0.155	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.33	0.23	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: SOIL)			Sample ID	pH and EC of DI Water	----	----	----	----
			Sampling date / time	19-Mar-2021 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2107418-034	--------	--------	--------	--------
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.8**	----	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	----	----	----	----

9.4.4 Attachment D4: Drill hole AG3 (Batch Number EB2112584)

CERTIFICATE OF ANALYSIS

Work Order	: **EB2112584**	Page	: 1 of 15
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALEXANDRA	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61 7 3552 8616
Project	: 2020057 Broadmeadow East	Date Samples Received	: 07-May-2021 16:50
Order number	: ----	Date Analysis Commenced	: 11-May-2021
C-O-C number	: ----	Issue Date	: 20-May-2021 17:02
Sampler	: ALEXANDRA KISS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 31		
No. of samples analysed	: 31		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Martina Louw	Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Vincent Muller		Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- ED007 (Exchangeable Cations by ICP-AES): Unable to calculate Magnesium/Potassium Ratio for some samples as required Exchangeable Magnesium and/or Potassium results are less than the limit of reporting.
- ED006 (Exchangeable Cations on Alkaline Soils): Sample 2020057_C1074 (EB2112584-001) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Magnesium/Potassium Ratio result for some samples as required Exchangeable Magnesium and/or Potassium results are less than the limit of reporting.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	2020057_C1074	2020057_C1075	2020057_C1076	2020057_C1077	2020057_C1078
Sampling date / time				07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
				EB2112584-001	EB2112584-002	EB2112584-003	EB2112584-004	EB2112584-005
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	8.1	8.3	8.3	8.4	8.3
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.3	9.4	9.7	9.7	9.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	349	651	617	593	498
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	5.9	4.9	9.1	6.4	4.1
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	0.3	1.1	1.3	0.3	0.4
ø Exchangeable Magnesium	----	0.2	meq/100g	3.4	5.0	5.4	3.8	3.2
ø Exchangeable Potassium	----	0.2	meq/100g	<0.2	0.2	<0.2	<0.2	<0.2
ø Exchangeable Sodium	----	0.2	meq/100g	1.5	3.0	4.2	3.1	2.8
ø Cation Exchange Capacity	----	0.2	meq/100g	5.4	9.3	11.1	7.3	6.5
ø Exchangeable Sodium Percent	----	0.2	%	28.3	32.3	38.1	43.0	43.4
ø Calcium/Magnesium Ratio	----	0.2	-	<0.2	0.2	0.2	<0.2	<0.2
ø Magnesium/Potassium Ratio	----	0.2	-	----	21.0	----	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	146	215	223	193	186
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	200	740	650	630	430
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	1.10	1.22	<1.00	<1.00	<1.00
ø Iron	7439-89-6	1.00	mg/kg	5.11	6.34	4.39	4.13	5.10
ø Manganese	7439-96-5	1.00	mg/kg	3.08	2.21	2.65	2.21	3.05
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	1.46	<1.00	<1.00	<1.00
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	0.3	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	0.4	1.9	0.9	0.1	0.9
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.4	1.9	1.2	0.1	0.9

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1074	2020057_C1075	2020057_C1076	2020057_C1077	2020057_C1078
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112584-001	EB2112584-002	EB2112584-003	EB2112584-004	EB2112584-005
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	180	180	370	250	230
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	180	180	370	250	230
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	108	118	440	374	380
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	6	<5	<5
EP004: Organic Matter								
Organic Matter	----	0.5	%	<0.5	<0.5	<0.5	<0.5	<0.5
Total Organic Carbon	----	0.5	%	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1079	2020057_C1080	2020057_C1081	2020057_C1082	2020057_C1083
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112584-006	EB2112584-007	EB2112584-008	EB2112584-009	EB2112584-010
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	6.2	7.5	8.2	8.3	8.3
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.3	8.3	9.5	9.8	9.6
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	23	322	468	468	623
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	3.3	8.2	8.4	6.0	7.6
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	----	1.5	1.1	<0.2	0.8
ø Exchangeable Magnesium	----	0.2	meq/100g	----	2.9	4.6	2.4	3.4
ø Exchangeable Potassium	----	0.2	meq/100g	----	0.2	<0.2	<0.2	<0.2
ø Exchangeable Sodium	----	0.2	meq/100g	----	0.9	2.7	2.3	2.9
ø Cation Exchange Capacity	----	0.2	meq/100g	----	5.6	8.6	4.7	7.0
ø Exchangeable Sodium Percent	----	0.2	%	----	16.0	31.3	48.4	40.7
ø Calcium/Magnesium Ratio	----	0.2	-	----	0.5	0.2	<0.2	0.2
ø Magnesium/Potassium Ratio	----	0.2	-	----	14.2	----	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	3.2	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	1.6	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.4	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	0.2	----	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	5.3	----	----	----	----
Exchangeable Sodium Percent	----	0.1	%	3.0	----	----	----	----
Calcium/Magnesium Ratio	----	0.1	-	2.0	----	----	----	----
Magnesium/Potassium Ratio	----	0.1	-	3.7	----	----	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	295	165	144	118	166
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	210	360	330	690
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ø Iron	7439-89-6	1.00	mg/kg	10.9	5.44	4.99	6.58	5.26
ø Manganese	7439-96-5	1.00	mg/kg	4.80	5.61	2.48	4.52	2.74
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1079	2020057_C1080	2020057_C1081	2020057_C1082	2020057_C1083
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112584-006	EB2112584-007	EB2112584-008	EB2112584-009	EB2112584-010
				Result	Result	Result	Result	Result
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	**0.3**	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	**0.5**	**1.2**	**0.7**	**0.5**	**0.4**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**0.5**	**1.2**	**1.0**	**0.5**	**0.4**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**350**	**330**	**160**	**140**	**230**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**350**	**330**	**160**	**140**	**230**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**139**	**121**	**98**	**290**	**305**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	<5	<5
EP004: Organic Matter								
Organic Matter	----	0.5	%	**0.9**	**0.7**	<0.5	<0.5	<0.5
Total Organic Carbon	----	0.5	%	**0.5**	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1084	2020057_C1085	2020057_C1086	2020057_C1087	2020057_C1088
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112584-011	EB2112584-012	EB2112584-013	EB2112584-014	EB2112584-015
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	6.5	8.0	8.1	8.2	8.1
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.3	8.6	9.2	9.4	9.2
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	75	33	102	212	305
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	6.3	4.4	4.8	5.1	3.2
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	----	4.7	2.6	1.6	0.7
ø Exchangeable Magnesium	----	0.2	meq/100g	----	3.9	2.8	3.7	2.3
ø Exchangeable Potassium	----	0.2	meq/100g	----	<0.2	<0.2	<0.2	<0.2
ø Exchangeable Sodium	----	0.2	meq/100g	----	0.5	0.3	0.8	0.4
ø Cation Exchange Capacity	----	0.2	meq/100g	----	9.2	5.7	6.1	3.4
ø Exchangeable Sodium Percent	----	0.2	%	----	5.6	5.2	12.7	12.7
ø Calcium/Magnesium Ratio	----	0.2	-	----	1.2	0.9	0.4	0.3
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	11.4	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	6.5	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.4	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	0.6	----	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	19.0	----	----	----	----
Exchangeable Sodium Percent	----	0.1	%	3.2	----	----	----	----
Calcium/Magnesium Ratio	----	0.1	-	1.8	----	----	----	----
Magnesium/Potassium Ratio	----	0.1	-	15.6	----	----	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	222	160	187	162	133
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	30	20	<10	120	310
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	1.50	<1.00	<1.00	<1.00	<1.00
ø Iron	7439-89-6	1.00	mg/kg	20.0	4.56	4.62	4.71	6.47
ø Manganese	7439-96-5	1.00	mg/kg	28.4	3.07	2.87	2.38	5.79
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
EK055: Ammonia as N								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1084	2020057_C1085	2020057_C1086	2020057_C1087	2020057_C1088
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112584-011	EB2112584-012	EB2112584-013	EB2112584-014	EB2112584-015
				Result	Result	Result	Result	Result
EK055: Ammonia as N - Continued								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	**0.1**	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	**2.1**	**0.4**	**0.6**	<0.1	**0.1**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**2.2**	**0.4**	**0.6**	<0.1	**0.1**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**620**	**170**	**150**	**160**	**110**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**620**	**170**	**150**	**160**	**110**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**145**	**265**	**333**	**296**	**316**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	<5	<5
EP004: Organic Matter								
Organic Matter	----	0.5	%	**1.8**	<0.5	<0.5	<0.5	<0.5
Total Organic Carbon	----	0.5	%	**1.0**	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1089	2020057_C1090	2020057_C1091	2020057_C1092	2020057_C1093
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112584-016	EB2112584-017	EB2112584-018	EB2112584-019	EB2112584-020
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	6.2	7.0	8.2	7.8	7.0
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.2	8.3	9.4	8.8	8.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	42	130	565	578	557
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	2.1	4.4	7.4	6.7	5.2
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	----	1.2	1.0	<0.2	<0.2
ø Exchangeable Magnesium	----	0.2	meq/100g	----	2.0	3.8	3.5	3.4
ø Exchangeable Potassium	----	0.2	meq/100g	----	<0.2	<0.2	<0.2	<0.2
ø Exchangeable Sodium	----	0.2	meq/100g	----	0.9	2.7	2.8	3.4
ø Cation Exchange Capacity	----	0.2	meq/100g	----	4.1	7.6	6.3	6.8
ø Exchangeable Sodium Percent	----	0.2	%	----	21.4	36.1	44.0	49.8
ø Calcium/Magnesium Ratio	----	0.2	-	----	0.6	0.3	<0.2	<0.2
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	3.1	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	1.6	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.3	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	0.3	----	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	5.4	----	----	----	----
Exchangeable Sodium Percent	----	0.1	%	6.2	----	----	----	----
Calcium/Magnesium Ratio	----	0.1	-	1.9	----	----	----	----
Magnesium/Potassium Ratio	----	0.1	-	4.9	----	----	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	195	<100	103	<100	116
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	30	110	470	780	840
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ø Iron	7439-89-6	1.00	mg/kg	17.9	7.70	6.24	6.02	6.56
ø Manganese	7439-96-5	1.00	mg/kg	22.0	9.83	4.36	4.22	2.42
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
EK055: Ammonia as N								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1089	2020057_C1090	2020057_C1091	2020057_C1092	2020057_C1093
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112584-016	EB2112584-017	EB2112584-018	EB2112584-019	EB2112584-020
				Result	Result	Result	Result	Result
EK055: Ammonia as N - Continued								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	**0.2**	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	**1.6**	**0.8**	**0.2**	<0.1	<0.1
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**1.8**	**0.8**	**0.2**	<0.1	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**310**	**190**	**160**	**90**	**80**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**310**	**190**	**160**	**90**	**80**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**195**	**173**	**133**	**176**	**222**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	<5	<5
EP004: Organic Matter								
Organic Matter	----	0.5	%	**0.9**	**0.6**	<0.5	<0.5	<0.5
Total Organic Carbon	----	0.5	%	**0.5**	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1094	2020057_C1095	2020057_C1096	2020057_C1097	2020057_C1098
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112584-021	EB2112584-022	EB2112584-023	EB2112584-024	EB2112584-025
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	6.7	8.0	7.3	7.4	7.5
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.6	9.3	8.9	8.9	9.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	121	249	129	232	318
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	2.0	6.3	4.2	4.4	4.2
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	2.0	3.2	2.2	1.6	1.7
ø Exchangeable Magnesium	----	0.2	meq/100g	0.4	4.3	3.3	2.6	3.2
ø Exchangeable Potassium	----	0.2	meq/100g	0.5	0.3	<0.2	<0.2	<0.2
ø Exchangeable Sodium	----	0.2	meq/100g	<0.2	1.9	2.8	2.0	2.0
ø Cation Exchange Capacity	----	0.2	meq/100g	3.0	9.8	8.5	6.2	6.9
ø Exchangeable Sodium Percent	----	0.2	%	<0.2	19.9	33.0	31.3	28.7
ø Calcium/Magnesium Ratio	----	0.2	-	4.4	0.8	0.6	0.6	0.5
ø Magnesium/Potassium Ratio	----	0.2	-	0.9	13.5	----	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	440	154	140	118	165
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	40	60	110	280	410
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ø Iron	7439-89-6	1.00	mg/kg	8.55	5.26	7.84	4.82	5.29
ø Manganese	7439-96-5	1.00	mg/kg	8.07	4.29	4.45	3.63	4.83
ø Zinc	7440-66-6	1.00	mg/kg	1.74	<1.00	1.33	<1.00	<1.00
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	25.5	0.6	0.8	0.3	0.7
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	25.6	0.6	0.8	0.3	0.7

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1094	2020057_C1095	2020057_C1096	2020057_C1097	2020057_C1098
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112584-021	EB2112584-022	EB2112584-023	EB2112584-024	EB2112584-025
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	270	130	160	80	200
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	300	130	160	80	200
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	84	80	129	81	114
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	<5	<5
EP004: Organic Matter								
Organic Matter	----	0.5	%	1.0	<0.5	<0.5	<0.5	<0.5
Total Organic Carbon	----	0.5	%	0.6	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1099	2020057_C1100	2020057_C1101	2020057_C1102	2020057_C1102_1
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112584-026	EB2112584-027	EB2112584-028	EB2112584-029	EB2112584-030
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	5.4	4.0	4.0	4.0	4.0
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.4	5.2	5.0	4.8	5.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	15	28	46	110	67
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	4.5	3.3	1.8	2.3	2.2
ED005: Exchange Acidity								
ø Exchange Acidity	----	0.1	meq/100g	----	1.6	0.9	0.6	0.9
ø Exchangeable Aluminium	----	0.1	meq/100g	----	1.2	0.7	0.4	0.6
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.8	0.4	0.2	0.2	0.2
Exchangeable Magnesium	----	0.1	meq/100g	1.2	1.1	0.8	0.8	0.9
Exchangeable Potassium	----	0.1	meq/100g	0.2	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.2	0.4	0.5	0.5
Cation Exchange Capacity	----	0.1	meq/100g	----	3.4	2.3	2.1	2.6
Cation Exchange Capacity	----	0.1	meq/100g	3.4	----	----	----	----
Exchangeable Sodium Percent	----	0.1	%	1.8	12.2	26.2	35.7	29.5
Calcium/Magnesium Ratio	----	0.1	-	1.5	0.4	0.2	0.2	0.2
Magnesium/Potassium Ratio	----	0.1	-	4.9	----	----	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	164	<100	<100	<100	<100
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	10	20	50	130	90
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	1.34	<1.00	<1.00	<1.00	<1.00
ø Iron	7439-89-6	1.00	mg/kg	14.3	8.98	10.2	11.8	11.0
ø Manganese	7439-96-5	1.00	mg/kg	2.50	1.69	1.03	1.40	1.42
ø Zinc	7440-66-6	1.00	mg/kg	16.4	1.43	<1.00	<1.00	<1.00
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1099	2020057_C1100	2020057_C1101	2020057_C1102	2020057_C1102_1
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112584-026	EB2112584-027	EB2112584-028	EB2112584-029	EB2112584-030
				Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	**1.3**	<0.1	<0.1	<0.1	<0.1
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**1.4**	<0.1	<0.1	<0.1	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**300**	**50**	<20	**40**	**30**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**300**	**50**	<20	**40**	**30**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**98**	**109**	**49**	**60**	**58**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	<5	<5
EP004: Organic Matter								
Organic Matter	----	0.5	%	**1.1**	**0.7**	<0.5	**0.5**	<0.5
Total Organic Carbon	----	0.5	%	**0.6**	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: SOIL)			Sample ID	pH and EC of DI water	----	----	----	----
			Sampling date / time	07-May-2021 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2112584-031	--------	--------	--------	--------
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.5**	----	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	----	----	----	----

9.4.5 Attachment D5: Test pit AG3 (Batch Number EB2105915)

CERTIFICATE OF ANALYSIS

Work Order	: **EB2105915**	Page	: 1 of 9
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR GREG MADDOCKS	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057 Broadmeadow East	Date Samples Received	: 03-Mar-2021 17:00
Order number	: ----	Date Analysis Commenced	: 04-Mar-2021
C-O-C number	: ----	Issue Date	: 11-Mar-2021 14:08
Sampler	: ALEXANDRA KISS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 13		
No. of samples analysed	: 13		

NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Arenie Vijayaratnam	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Exchangeable Percent results for Sample 2020057_C2012 (EB2105915-012) as required Calcium, Magnesium, Potassium & Sodium results are less than the limit of reporting.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Calcium/Magnesium Ratio for some samples result as required Exchangeable Calcium & Magnesium results are less than the limit of reporting.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Magnesium/Potassium Ratio result for some samples as required Exchangeable Magnesium and/or Potassium results are less than the limit of reporting.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C2001	2020057_C2002	2020057_C2003	2020057_C2004	2020057_C2005
			Sampling date / time	03-Mar-2021 00:00	03-Mar-2021 00:00	03-Mar-2021 00:00	03-Mar-2021 00:00	03-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2105915-001	EB2105915-002	EB2105915-003	EB2105915-004	EB2105915-005
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	7.6	8.0	8.1	7.8	7.4
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.8	9.3	9.3	9.0	8.3
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	212	455	781	444	83
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	7.1	8.1	8.8	5.9	12.1
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	5.5	2.6	3.0	1.6	12.1
ø Exchangeable Magnesium	----	0.2	meq/100g	3.8	3.6	5.4	3.7	2.8
ø Exchangeable Potassium	----	0.2	meq/100g	0.6	0.2	0.3	<0.2	0.4
ø Exchangeable Sodium	----	0.2	meq/100g	1.0	1.8	3.4	2.8	<0.2
ø Cation Exchange Capacity	----	0.2	meq/100g	10.9	8.2	12.0	8.3	15.3
ø Exchangeable Sodium Percent	----	0.2	%	9.0	21.8	28.2	33.6	<0.2
ø Calcium/Magnesium Ratio	----	0.2	-	1.5	0.7	0.5	0.4	4.3
ø Magnesium/Potassium Ratio	----	0.2	-	6.4	14.5	20.5	----	6.4
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	340	188	166	195	211
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	90	440	1110	630	10
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ø Iron	7439-89-6	1.00	mg/kg	18.3	10.7	8.83	5.82	5.52
ø Manganese	7439-96-5	1.00	mg/kg	11.1	6.52	3.73	1.98	6.44
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	0.7	0.8	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	8.3	5.3	1.6	0.4	0.9
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	9.0	6.1	1.6	0.4	0.9

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

			Sample ID	2020057_C2001	2020057_C2002	2020057_C2003	2020057_C2004	2020057_C2005
			Sampling date / time	03-Mar-2021 00:00	03-Mar-2021 00:00	03-Mar-2021 00:00	03-Mar-2021 00:00	03-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2105915-001	EB2105915-002	EB2105915-003	EB2105915-004	EB2105915-005
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**830**	**460**	**310**	**180**	<20
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**840**	**470**	**310**	**180**	<20
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**237**	**245**	**227**	**224**	**172**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	**7**	<5	<5	<5	<5
EP004: Organic Matter								
Organic Matter	----	0.5	%	**2.1**	**1.0**	**0.6**	<0.5	**1.3**
Total Organic Carbon	----	0.5	%	**1.2**	**0.6**	<0.5	<0.5	**0.7**

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	2020057_C2006	2020057_C2007	2020057_C2008	2020057_C2009	2020057_C2010
Sampling date / time				03-Mar-2021 00:00	03-Mar-2021 00:00	03-Mar-2021 00:00	03-Mar-2021 00:00	03-Mar-2021 00:00
				EB2105915-006	EB2105915-007	EB2105915-008	EB2105915-009	EB2105915-010
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	7.7	7.9	8.0	7.6	7.9
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.7	9.2	9.2	8.6	9.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	112	85	82	121	164
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	7.4	4.8	11.1	8.3	11.5
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	8.8	7.4	6.3	5.5	5.4
ø Exchangeable Magnesium	----	0.2	meq/100g	2.8	2.9	2.5	2.0	4.0
ø Exchangeable Potassium	----	0.2	meq/100g	0.2	<0.2	<0.2	0.2	0.3
ø Exchangeable Sodium	----	0.2	meq/100g	0.2	0.4	0.3	0.3	0.8
ø Cation Exchange Capacity	----	0.2	meq/100g	12.1	10.8	9.1	8.1	10.5
ø Exchangeable Sodium Percent	----	0.2	%	1.9	3.4	3.5	3.5	7.3
ø Calcium/Magnesium Ratio	----	0.2	-	3.2	2.5	2.5	2.7	1.4
ø Magnesium/Potassium Ratio	----	0.2	-	12.0	----	----	8.3	13.7
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	182	173	160	144	170
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	20	20	10	40	80
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ø Iron	7439-89-6	1.00	mg/kg	4.98	5.52	6.15	9.62	7.76
ø Manganese	7439-96-5	1.00	mg/kg	4.98	2.92	3.54	5.76	3.80
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	1.6	0.4	0.3	6.0	2.5
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	1.6	0.4	0.3	6.0	2.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C2006	2020057_C2007	2020057_C2008	2020057_C2009	2020057_C2010
			Sampling date / time	03-Mar-2021 00:00	03-Mar-2021 00:00	03-Mar-2021 00:00	03-Mar-2021 00:00	03-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2105915-006	EB2105915-007	EB2105915-008	EB2105915-009	EB2105915-010
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**520**	**220**	**230**	**550**	**390**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**520**	**220**	**230**	**560**	**390**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**253**	**365**	**410**	**231**	**261**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	<5	<5
EP004: Organic Matter								
Organic Matter	----	0.5	%	**0.9**	<0.5	<0.5	**1.1**	**0.6**
Total Organic Carbon	----	0.5	%	**0.5**	<0.5	<0.5	**0.6**	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C2011	2020057_C2012	----	----	----
			Sampling date / time	03-Mar-2021 00:00	03-Mar-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2105915-011	EB2105915-012	--------	--------	--------
				Result	Result	----	----	----
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	7.8	8.1	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.2	9.5	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	218	463	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	7.3	9.4	----	----	----
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	3.4	<0.2	----	----	----
ø Exchangeable Magnesium	----	0.2	meq/100g	4.4	<0.2	----	----	----
ø Exchangeable Potassium	----	0.2	meq/100g	<0.2	<0.2	----	----	----
ø Exchangeable Sodium	----	0.2	meq/100g	2.3	<0.2	----	----	----
ø Cation Exchange Capacity	----	0.2	meq/100g	10.2	<0.2	----	----	----
ø Exchangeable Sodium Percent	----	0.2	%	22.3	----	----	----	----
ø Calcium/Magnesium Ratio	----	0.2	-	0.8	----	----	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	109	102	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	190	460	----	----	----
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	----	----	----
ø Iron	7439-89-6	1.00	mg/kg	6.14	5.23	----	----	----
ø Manganese	7439-96-5	1.00	mg/kg	4.11	3.31	----	----	----
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	----	----	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	0.8	0.7	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.8	0.7	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C2011	2020057_C2012	----	----	----
			Sampling date / time	03-Mar-2021 00:00	03-Mar-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2105915-011	EB2105915-012	--------	--------	--------
				Result	Result	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**210**	**190**	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**210**	**190**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**253**	**227**	----	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	----	----	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	<0.5	<0.5	----	----	----
Total Organic Carbon	----	0.5	%	<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: SOIL)			Sample ID	pH and EC of DI water	----	----	----	----
			Sampling date / time	03-Mar-2021 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2105915-013	--------	--------	--------	--------
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.9**	----	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	----	----	----	----

Inter-Laboratory Testing

Analysis conducted by ALS Melbourne, NATA accreditation no. 825, site no. 13778 (Chemistry).

(SOIL) EK062: Total Nitrogen as N (TKN + NOx)

(SOIL) EK061G: Total Kjeldahl Nitrogen By Discrete Analyser

(SOIL) EK067G: Total Phosphorus as P by Discrete Analyser

9.4.6 Attachment D4: Drill hole and coal quality, MEMS41, Shake Flask, CRS (Batch Number EB2112627)

CERTIFICATE OF ANALYSIS

Work Order	: **EB2112627**	Page	: 1 of 31
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR GREG MADDOCKS	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2020057 Broadmeadow East	Date Samples Received	: 07-May-2021 16:50
Order number	: ----	Date Analysis Commenced	: 11-May-2021
C-O-C number	: ----	Issue Date	: 27-May-2021 16:51
Sampler	: ALEXANDRA KISS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 36		
No. of samples analysed	: 36		

NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Inorganics, Stafford, QLD
Janice Blake	Laboratory Technician	Newcastle - Inorganics, Mayfield West, NSW
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ALS is not NATA accredited for the performance of EN35: Miscellaneous Leaching procedure.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1103	2020057_C1104	2020057_C1105	2020057_C1106	2020057_C1107
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-001	EB2112627-002	EB2112627-003	EB2112627-004	EB2112627-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.13	8.65	8.93	8.28	8.36
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	808	740	548	670	778
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	16	24	<1	2
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	140	104	115	139	83
Total Alkalinity as CaCO3	----	1	mg/L	140	120	139	139	85
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	4	<1	<1	<1	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	17	30	35	19	15
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	166	140	63	114	184
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	2	1	<1	2	2
Magnesium	7439-95-4	1	mg/L	1	<1	<1	2	2
Sodium	7440-23-5	1	mg/L	158	144	108	133	162
Potassium	7440-09-7	1	mg/L	2	2	5	2	2
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	4.08	1.43	4.36	4.40	0.98
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	0.001	0.011	0.157	0.003	<0.001
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	2.67	1.67	0.35	1.03	0.40
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	0.044	0.028	0.040	0.057	0.041
Barium	7440-39-3	0.001	mg/L	1.43	0.535	0.626	1.17	0.687
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L	0.09	0.04	0.14	0.11	0.01
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1103	2020057_C1104	2020057_C1105	2020057_C1106	2020057_C1107
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-001	EB2112627-002	EB2112627-003	EB2112627-004	EB2112627-005
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	**0.0001**	<0.0001
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	**0.001**	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	**0.003**	**0.001**	**0.003**	**0.004**	**0.002**
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.006**	**0.004**	**0.002**	**0.005**	**0.001**
Lanthanum	7439-91-0	0.001	mg/L	**0.001**	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L	**0.006**	**0.003**	**0.008**	**0.005**	**0.003**
Lithium	7439-93-2	0.001	mg/L	**0.002**	**0.004**	**0.006**	**0.002**	**0.002**
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L	**0.003**	<0.001	<0.001	**0.002**	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.021**	**0.003**	**0.004**	**0.022**	**0.017**
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L	**0.002**	**0.016**	**0.055**	**0.003**	**0.002**
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	<0.001	**0.001**	**0.002**	<0.001
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	**0.002**	<0.001	**0.001**	**0.002**	<0.001
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L	<0.001	**0.003**	**0.004**	<0.001	<0.001
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	**0.01**	**0.02**	<0.01	<0.01
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L	**0.001**	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L	**0.005**	<0.005	<0.005	<0.005	<0.005
Vanadium	7440-62-2	0.01	mg/L	**0.02**	<0.01	**0.02**	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.717**	**0.083**	**0.074**	**0.394**	**0.068**
Iron	7439-89-6	0.05	mg/L	**1.54**	**0.18**	**0.45**	**1.82**	**0.26**

Analytical Results

Sub-Matrix: **DI WATER LEACHATE**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	2020057_C1103	2020057_C1104	2020057_C1105	2020057_C1106	2020057_C1107
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
				EB2112627-001	EB2112627-002	EB2112627-003	EB2112627-004	EB2112627-005
				Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**2.8**	**1.1**	**0.5**	**2.0**	**2.1**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**1.00**	**0.04**	**0.01**	**2.23**	**0.04**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.4**	<0.1	**0.3**	**0.6**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**1.4**	<0.1	**0.3**	**2.8**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.13**	**0.06**	**0.12**	**0.04**	**0.01**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	**0.01**	<0.01	<0.01

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1108	2020057_C1109	2020057_C1110	2020057_C1111	2020057_C1112
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-006	EB2112627-007	EB2112627-008	EB2112627-009	EB2112627-010
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.37	8.48	8.28	8.16	8.21
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	847	666	645	292	568
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	3	6	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	112	108	99	83	85
Total Alkalinity as CaCO3	----	1	mg/L	115	114	99	83	85
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	<1	<1	<1	<1	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	28	42	123	1	23
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	188	110	55	38	108
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	2	2	1	7	5
Magnesium	7439-95-4	1	mg/L	2	2	1	6	5
Sodium	7440-23-5	1	mg/L	122	129	126	46	100
Potassium	7440-09-7	1	mg/L	4	4	4	1	2
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.85	1.57	1.67	1.28	0.98
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	0.003	0.046	0.035	0.001	0.003
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	0.23	0.24	0.37	0.31	0.26
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	0.069	0.069	0.046	0.131	0.136
Barium	7440-39-3	0.001	mg/L	0.572	0.606	0.587	0.832	0.864
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L	0.03	0.05	0.04	0.05	0.04
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1108	2020057_C1109	2020057_C1110	2020057_C1111	2020057_C1112
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-006	EB2112627-007	EB2112627-008	EB2112627-009	EB2112627-010
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	**0.001**	**0.002**	**0.001**	**0.002**	**0.001**
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	**0.002**	**0.005**	**0.003**	**0.009**
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L	**0.004**	**0.004**	**0.005**	**0.002**	**0.003**
Lithium	7439-93-2	0.001	mg/L	**0.005**	**0.008**	**0.006**	**0.001**	**0.006**
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.006**	**0.005**	**0.007**	**0.010**	**0.009**
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L	**0.005**	**0.035**	**0.141**	**0.002**	**0.032**
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L	**0.001**	**0.006**	**0.012**	<0.001	<0.001
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	**0.02**	**0.04**	<0.01	<0.01
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.038**	**0.048**	**0.058**	**0.073**	**0.065**
Iron	7439-89-6	0.05	mg/L	**0.14**	**0.18**	**0.24**	**0.59**	**0.20**

Analytical Results

Sub-Matrix: **DI WATER LEACHATE** (Matrix: **WATER**)			Sample ID	2020057_C1108	2020057_C1109	2020057_C1110	2020057_C1111	2020057_C1112
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-006	EB2112627-007	EB2112627-008	EB2112627-009	EB2112627-010
				Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.7**	**0.6**	**0.6**	**2.7**	**1.6**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.26**	**0.03**	<0.01	**0.14**	**0.03**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	**0.1**	<0.1	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.3**	<0.1	**0.1**	**0.1**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.01**	**0.04**	**0.03**	**0.01**	**0.01**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	**0.01**	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1113	2020057_C1114	2020057_C1115	2020057_C1116	2020057_C1117
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-011	EB2112627-012	EB2112627-013	EB2112627-014	EB2112627-015
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.36	8.31	8.21	8.30	8.61
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	484	867	940	834	496
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	2	<1	<1	<1	16
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	118	149	159	110	170
Total Alkalinity as CaCO3	----	1	mg/L	120	150	159	110	186
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	<1	<1	<1	<1	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	100	34	58	31	18
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	11	163	169	181	34
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	2	2	1	3	2
Magnesium	7439-95-4	1	mg/L	2	2	1	3	1
Sodium	7440-23-5	1	mg/L	103	174	199	161	110
Potassium	7440-09-7	1	mg/L	6	1	1	5	4
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	2.30	2.60	1.27	1.21	2.09
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	0.020	0.002	0.003	0.006	0.003
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	0.27	1.04	0.68	0.61	0.65
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	0.115	0.057	0.031	0.113	0.071
Barium	7440-39-3	0.001	mg/L	0.742	1.11	0.584	0.871	0.929
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L	0.05	0.08	0.03	0.03	0.06
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1113	2020057_C1114	2020057_C1115	2020057_C1116	2020057_C1117
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-011	EB2112627-012	EB2112627-013	EB2112627-014	EB2112627-015
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	**0.0001**	**0.0001**	<0.0001	<0.0001	<0.0001
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	**0.002**	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	**0.001**	**0.004**	**0.001**	**0.001**	**0.002**
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.001**	**0.009**	**0.002**	<0.001	**0.014**
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L	**0.007**	**0.003**	**0.003**	**0.006**	**0.005**
Lithium	7439-93-2	0.001	mg/L	**0.008**	**0.001**	**0.002**	**0.003**	**0.004**
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.006**	**0.011**	**0.004**	**0.005**	**0.009**
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L	**0.141**	**0.005**	**0.011**	**0.001**	**0.002**
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.001**	<0.001	<0.001	<0.001
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	**0.001**	<0.001	<0.001	**0.004**
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L	**0.012**	<0.001	**0.001**	**0.001**	<0.001
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	**0.04**	<0.01	<0.01	<0.01	<0.01
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.074**	**0.358**	**0.109**	**0.309**	**0.343**
Iron	7439-89-6	0.05	mg/L	**0.52**	**1.08**	**0.37**	**0.24**	**0.90**

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1113	2020057_C1114	2020057_C1115	2020057_C1116	2020057_C1117
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-011	EB2112627-012	EB2112627-013	EB2112627-014	EB2112627-015
				Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.4**	**2.3**	**2.2**	**0.4**	**0.4**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**0.16**	**0.01**	**0.18**	**1.29**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.2**	**0.1**	<0.1	**0.4**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.2**	**0.4**	**0.1**	**0.2**	**1.7**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.04**	**0.04**	**0.02**	**0.04**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **DI WATER LEACHATE**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	2020057_C1118	2020057_C1119	2020057_C1120	2020057_C1121	2020057_C1122
Sampling date / time				07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
				EB2112627-016	EB2112627-017	EB2112627-018	EB2112627-019	EB2112627-020
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.59	8.06	8.41	8.43	8.61
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	452	428	497	383	390
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	12	<1	5	5	10
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	116	69	120	118	106
Total Alkalinity as CaCO3	----	1	mg/L	128	69	125	123	116
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	<1	1	<1	<1	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	62	17	13	26	24
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	24	78	77	28	36
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	2	2	1	1	<1
Magnesium	7439-95-4	1	mg/L	<1	1	1	1	<1
Sodium	7440-23-5	1	mg/L	99	83	99	81	82
Potassium	7440-09-7	1	mg/L	3	2	2	5	5
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	4.85	3.99	3.05	4.99	3.02
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	0.047	0.003	0.001	0.020	0.030
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	0.59	0.77	0.71	0.45	0.50
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	0.038	0.045	0.034	0.046	0.032
Barium	7440-39-3	0.001	mg/L	0.957	1.50	1.46	1.05	0.912
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L	0.13	0.09	0.09	0.19	0.11
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L	0.001	0.001	<0.001	0.001	<0.001

Analytical Results

Sub-Matrix: **DI WATER LEACHATE** (Matrix: **WATER**)			Sample ID	2020057_C1118	2020057_C1119	2020057_C1120	2020057_C1121	2020057_C1122
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-016	EB2112627-017	EB2112627-018	EB2112627-019	EB2112627-020
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	**0.0002**	**0.0001**	<0.0001	<0.0001
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.005**	**0.002**	<0.001	<0.001
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	**0.003**	**0.005**	**0.003**	**0.008**	**0.002**
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.004**	**0.008**	**0.005**	**0.004**	**0.003**
Lanthanum	7439-91-0	0.001	mg/L	<0.001	**0.003**	**0.001**	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L	**0.007**	**0.004**	**0.005**	**0.008**	**0.007**
Lithium	7439-93-2	0.001	mg/L	**0.008**	**0.002**	**0.002**	**0.006**	**0.002**
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L	<0.001	**0.010**	**0.002**	**0.001**	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.003**	**0.155**	**0.046**	**0.006**	**0.006**
Neodymium	7440-00-8	0.001	mg/L	<0.001	**0.004**	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L	**0.063**	**0.001**	**0.002**	**0.016**	**0.003**
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.004**	**0.003**	**0.002**	**0.001**
Samarium	7440-19-9	0.001	mg/L	<0.001	**0.001**	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	**0.019**	**0.033**	**0.012**	**0.006**	**0.007**
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L	**0.011**	<0.001	<0.001	**0.003**	**0.002**
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	**0.04**	<0.01	<0.01	**0.01**	<0.01
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L	<0.001	**0.003**	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L	**0.006**	<0.005	<0.005	**0.006**	<0.005
Vanadium	7440-62-2	0.01	mg/L	<0.01	**0.02**	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.091**	**0.183**	**0.318**	**0.184**	**0.200**
Iron	7439-89-6	0.05	mg/L	**0.71**	**2.17**	**1.69**	**0.85**	**0.96**

Analytical Results

Sub-Matrix: **DI WATER LEACHATE**
(Matrix: **WATER)**

Compound	CAS Number	LOR	Unit	2020057_C1118	2020057_C1119	2020057_C1120	2020057_C1121	2020057_C1122
Sampling date / time				07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
				EB2112627-016	EB2112627-017	EB2112627-018	EB2112627-019	EB2112627-020
				Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.4**	**1.3**	**1.2**	**0.5**	**0.5**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.48**	**0.93**	**0.36**	**0.06**	**1.53**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	**0.6**	**0.4**	**0.1**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.5**	**1.5**	**0.8**	**0.2**	**1.7**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.32**	**0.20**	**0.08**	**0.04**	**0.03**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	**0.02**	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1123	2020057_C1124	2020057_C1125	2020057_C1126	2020057_C1127
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-021	EB2112627-022	EB2112627-023	EB2112627-024	EB2112627-025
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.27	7.57	7.53	8.07	8.16
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	499	1380	1130	413	729
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	113	30	28	72	104
Total Alkalinity as CaCO3	----	1	mg/L	113	30	28	72	104
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	3	4	4	<1	1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	100	769	605	96	247
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	21	4	1	17	9
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	10	194	153	11	32
Magnesium	7439-95-4	1	mg/L	8	87	65	5	21
Sodium	7440-23-5	1	mg/L	76	45	42	115	78
Potassium	7440-09-7	1	mg/L	9	7	8	12	11
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	1.17	0.25	0.23	2.42	0.10
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	0.002	<0.001	<0.001	0.134	0.002
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	0.45	0.09	0.07	5.39	0.36
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	0.363	2.17	2.15	0.247	1.03
Barium	7440-39-3	0.001	mg/L	1.34	0.046	0.042	1.18	0.587
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L	0.03	0.02	0.01	0.04	<0.01
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1123	2020057_C1124	2020057_C1125	2020057_C1126	2020057_C1127
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-021	EB2112627-022	EB2112627-023	EB2112627-024	EB2112627-025
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	**0.0001**	**0.0004**	**0.0003**	**0.0002**	**0.0003**
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.043**	**0.021**	**0.003**	**0.002**
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	**0.001**	<0.001	<0.001	**0.001**	<0.001
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	**0.002**	<0.001
Chromium	7440-47-3	0.001	mg/L	**0.002**	<0.001	<0.001	**0.018**	<0.001
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.002**	<0.001	<0.001	**0.022**	**0.003**
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	**0.001**	<0.001
Rubidium	7440-17-7	0.001	mg/L	**0.008**	**0.007**	**0.006**	**0.011**	**0.008**
Lithium	7439-93-2	0.001	mg/L	**0.012**	**0.043**	**0.031**	**0.010**	**0.018**
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	**0.003**	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.021**	**4.25**	**2.32**	**0.048**	**0.066**
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	**0.001**	<0.001
Molybdenum	7439-98-7	0.001	mg/L	**0.065**	<0.001	<0.001	**0.231**	**0.092**
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.092**	**0.045**	**0.013**	**0.003**
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	**0.003**	<0.001	<0.001	**0.021**	**0.003**
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L	**0.006**	<0.001	<0.001	**0.027**	**0.003**
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	**0.03**	**0.02**	**0.02**	**0.06**	**0.04**
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.154**	**0.125**	**0.092**	**0.138**	**0.086**
Iron	7439-89-6	0.05	mg/L	**0.19**	<0.05	<0.05	**0.73**	<0.05

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1123	2020057_C1124	2020057_C1125	2020057_C1126	2020057_C1127
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-021	EB2112627-022	EB2112627-023	EB2112627-024	EB2112627-025
				Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.4**	**0.2**	**0.2**	**0.4**	**0.3**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.06**	<0.01	<0.01	**0.06**	**2.08**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.1**	**0.2**	<0.1	**0.2**	**0.4**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.2**	**0.2**	<0.1	**0.3**	**2.5**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	**0.05**	**0.01**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1128	2020057_C1129	2020057_C1130	2020057_C1131	2020057_C1132
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-026	EB2112627-027	EB2112627-028	EB2112627-029	EB2112627-030
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.11	8.23	8.20	8.30	8.31
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	122	383	285	382	464
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	6	107	88	116	129
Total Alkalinity as CaCO3	----	1	mg/L	6	107	88	116	129
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	2	<1	<1	<1	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	10	27	30	56	87
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	26	38	13	12	12
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	9	5	10	15
Magnesium	7439-95-4	1	mg/L	<1	7	5	12	16
Sodium	7440-23-5	1	mg/L	21	57	43	47	48
Potassium	7440-09-7	1	mg/L	<1	4	6	11	11
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.25	0.84	1.48	0.46	0.21
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.014	0.003	0.001
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	0.35	0.34	0.36	0.33	0.39
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	0.030	0.122	0.146	0.408	0.549
Barium	7440-39-3	0.001	mg/L	0.669	1.14	0.978	1.10	1.02
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L	<0.01	0.05	0.05	0.02	<0.01
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1128	2020057_C1129	2020057_C1130	2020057_C1131	2020057_C1132
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-026	EB2112627-027	EB2112627-028	EB2112627-029	EB2112627-030
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	**0.0001**	<0.0001	**0.0001**	**0.0002**
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	7440-48-4	0.001	mg/L	**0.001**	<0.001	<0.001	<0.001	<0.001
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**0.001**
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	**0.001**	**0.001**	**0.009**	<0.001
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.002**	**0.004**	**0.007**	**0.014**
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L	<0.001	**0.003**	**0.006**	**0.008**	**0.008**
Lithium	7439-93-2	0.001	mg/L	**0.013**	**0.002**	**0.004**	**0.007**	**0.010**
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.013**	**0.016**	**0.006**	**0.015**	**0.048**
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L	**0.001**	**0.002**	**0.018**	**0.050**	**0.069**
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	**0.001**	**0.001**
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	**0.006**	**0.003**	**0.003**	**0.006**
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	**0.003**	**0.005**	**0.004**
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	**0.01**	**0.02**	**0.02**
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.046**	**0.088**	**0.072**	**0.059**	**0.086**
Iron	7439-89-6	0.05	mg/L	**0.07**	**0.25**	**0.23**	**0.09**	<0.05

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1128	2020057_C1129	2020057_C1130	2020057_C1131	2020057_C1132
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-026	EB2112627-027	EB2112627-028	EB2112627-029	EB2112627-030
				Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	**1.3**	**0.8**	**0.6**	**0.5**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**2.21**	**0.12**	<0.01	**1.74**	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.4**	<0.1	<0.1	**0.2**	**0.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**2.6**	**0.1**	<0.1	**1.9**	**0.1**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.03**	**0.02**	**0.02**	**0.01**	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	**0.02**	<0.01	<0.01

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1133	2020057_C1134	2020057_C3007	2020057_C3008	2020057_C3009
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-031	EB2112627-032	EB2112627-033	EB2112627-034	EB2112627-035
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.94	7.82	8.42	8.12	8.17
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	753	1340	658	627	549
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	4	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	53	44	122	78	78
Total Alkalinity as CaCO3	----	1	mg/L	53	44	126	78	78
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	2	3	<1	<1	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	323	718	97	183	84
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	8	3	63	27	59
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	44	228	3	27	<1
Magnesium	7439-95-4	1	mg/L	35	34	3	11	<1
Sodium	7440-23-5	1	mg/L	52	21	127	99	105
Potassium	7440-09-7	1	mg/L	12	6	5	5	3
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.11	0.06	2.22	0.34	1.68
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.019	<0.001	0.125
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	0.37	0.09	0.36	0.10	0.45
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	1.31	1.65	0.147	1.50	0.063
Barium	7440-39-3	0.001	mg/L	0.481	0.049	0.827	0.107	0.749
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	0.04	0.02	0.06
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: **DI WATER LEACHATE** (Matrix: **WATER**)			Sample ID	2020057_C1133	2020057_C1134	2020057_C3007	2020057_C3008	2020057_C3009
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-031	EB2112627-032	EB2112627-033	EB2112627-034	EB2112627-035
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Cadmium	7440-43-9	0.0001	mg/L	**0.0003**	<0.0001	**0.0002**	<0.0001	**0.0001**
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	7440-48-4	0.001	mg/L	**0.008**	**0.001**	<0.001	<0.001	<0.001
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	**0.001**	<0.001	**0.001**
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.008**	<0.001	**0.002**	<0.001	**0.005**
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L	**0.009**	**0.004**	**0.007**	**0.005**	**0.005**
Lithium	7439-93-2	0.001	mg/L	**0.032**	**0.012**	**0.008**	**0.017**	**0.007**
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.150**	**0.227**	**0.005**	**0.025**	**0.003**
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L	**0.013**	**0.004**	**0.302**	**0.043**	**0.227**
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.012**	**0.001**	<0.001	**0.003**	<0.001
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	**0.006**	<0.001	**0.004**	<0.001	**0.006**
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L	**0.002**	<0.001	**0.015**	<0.001	**0.008**
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	**0.06**	<0.01	**0.06**	<0.01	**0.08**
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.157**	**0.093**	**0.065**	**0.074**	**0.104**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.34**	**0.13**	**0.31**

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Sample ID	2020057_C1133	2020057_C1134	2020057_C3007	2020057_C3008	2020057_C3009
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-031	EB2112627-032	EB2112627-033	EB2112627-034	EB2112627-035
				Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.3**	**0.2**	**0.6**	**0.2**	**0.6**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**1.12**	<0.01	**0.02**	**0.01**	**0.06**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	<0.1	**0.2**	**0.2**	**0.5**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**1.3**	<0.1	**0.2**	**0.2**	**0.6**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	**0.03**	**0.02**	**0.12**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	**0.01**

Analytical Results

Sub-Matrix: **DI WATER** (Matrix: **WATER**)			Sample ID	**pH and EC of DI water**	**----**	**----**	**----**	**----**
			Sampling date / time	07-May-2021 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2112627-036**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.00**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1103	2020057_C1104	2020057_C1105	2020057_C1106	2020057_C1107
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-001	EB2112627-002	EB2112627-003	EB2112627-004	EB2112627-005
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.007**	**0.013**	**0.020**	**0.009**	**0.010**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**6.8**	**4.6**	**2.6**	**7.0**	**5.8**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	**150**	**150**	**200**	**130**	**140**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1108	2020057_C1109	2020057_C1110	2020057_C1111	2020057_C1112
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-006	EB2112627-007	EB2112627-008	EB2112627-009	EB2112627-010
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.013**	**0.010**	**0.129**	<0.005	**0.017**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**11.7**	**14.0**	**4.9**	**4.4**	**4.9**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	**150**	**170**	**150**	**150**	**170**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1113	2020057_C1114	2020057_C1115	2020057_C1116	2020057_C1117
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-011	EB2112627-012	EB2112627-013	EB2112627-014	EB2112627-015
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.069**	**0.010**	**0.015**	**0.078**	**0.011**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**3.6**	**5.9**	**6.0**	**12.3**	**8.4**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	**170**	**60**	**160**	**100**	**180**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1118	2020057_C1119	2020057_C1120	2020057_C1121	2020057_C1122
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-016	EB2112627-017	EB2112627-018	EB2112627-019	EB2112627-020
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.024**	**0.009**	**0.009**	**0.013**	**0.025**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**6.4**	**5.0**	**4.4**	**4.2**	**5.3**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	**150**	**50**	**100**	**160**	**140**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1123	2020057_C1124	2020057_C1125	2020057_C1126	2020057_C1127
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-021	EB2112627-022	EB2112627-023	EB2112627-024	EB2112627-025
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.121**	**0.699**	**0.392**	**0.104**	**0.298**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**7.0**	**5.3**	**7.2**	**4.1**	**5.9**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	**200**	**210**	**180**	**200**	**210**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1128	2020057_C1129	2020057_C1130	2020057_C1131	2020057_C1132
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-026	EB2112627-027	EB2112627-028	EB2112627-029	EB2112627-030
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.010**	**0.013**	**0.020**	**0.033**	**0.100**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**2.7**	**3.6**	**3.7**	**5.1**	**5.3**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	**50**	**130**	**160**	**200**	**210**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2020057_C1133	2020057_C1134	2020057_C3007	2020057_C3008	2020057_C3009
			Sampling date / time	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00	07-May-2021 00:00
Compound	CAS Number	LOR	Unit	EB2112627-031	EB2112627-032	EB2112627-033	EB2112627-034	EB2112627-035
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.185**	**1.34**	**0.152**	**0.404**	**0.160**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**7.3**	**16.0**	**2.2**	**0.3**	**1.9**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	**0.2**	**0.2**
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	**120**	**180**	**360**	**240**	**160**

Inter-Laboratory Testing

Analysis conducted by ALS Newcastle, NATA accreditation no. 825, site no. 1656 (Chemistry) 9854 (Biology).

(SOIL) EK040T: Fluoride Total

9.5 Attachment E: Trilab physical reports

9.5.1 PSD and hydrometer

Trilab
Soil Rock Calibration

Brisbane
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Geebung
QLD 4034
Ph: +61 7 3265 5656

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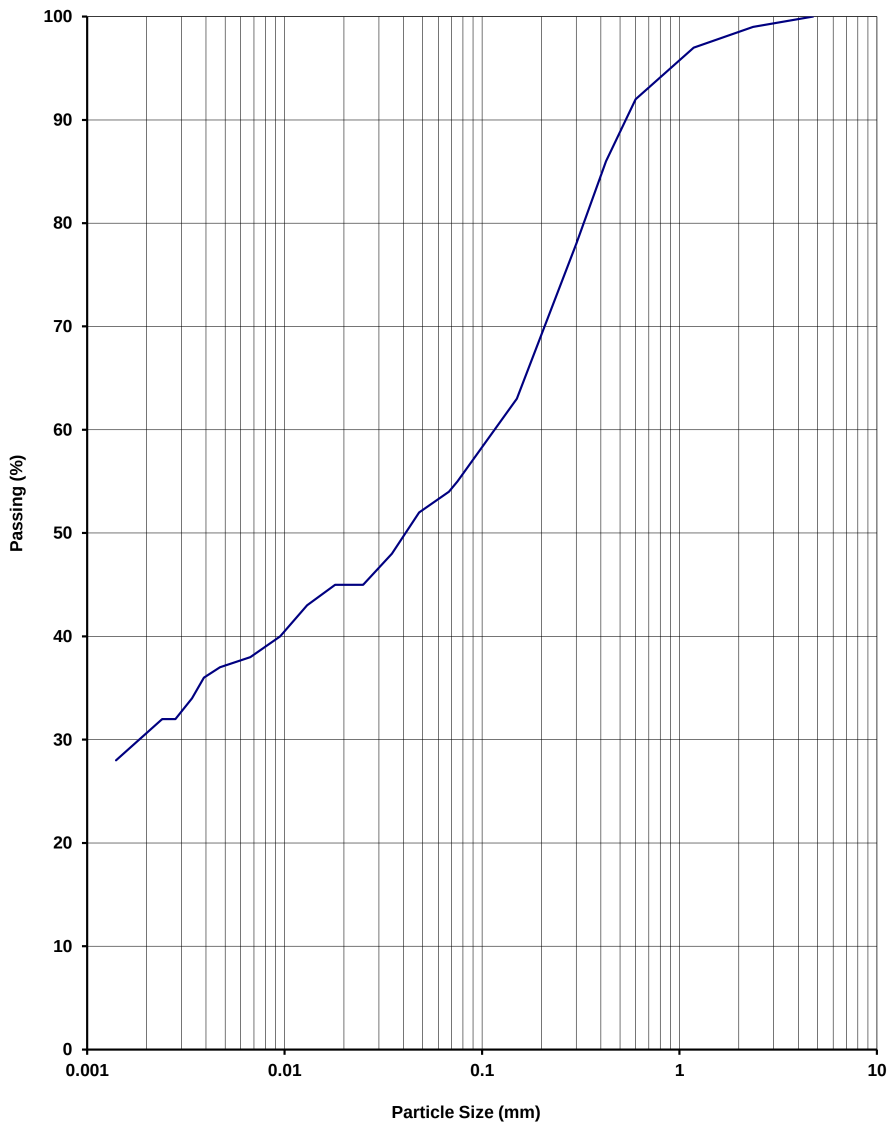
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030889-G
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/21-31/3/21
		Report Date	31/3/2021
Project	2020057 - Broadmeadow East		
Client ID	1 - 2020057_C2001	**Depth (m)**	0.00-0.50

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	99
1.18	97
0.600	92
0.425	86
0.300	78
0.150	63
0.075	55
0.068	54
0.048	52
0.035	48
0.025	45
0.018	45
0.013	43
0.0095	40
0.0067	38
0.0047	37
0.0039	36
0.0034	34
0.0028	32
0.0024	32
0.0014	28



NOTES/REMARKS: -

Moisture Content 9% -2.36mm Soil Particle Density(t/m^3) 2.49

Sample/s supplied by the client

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Authorised Signatory

C. Park

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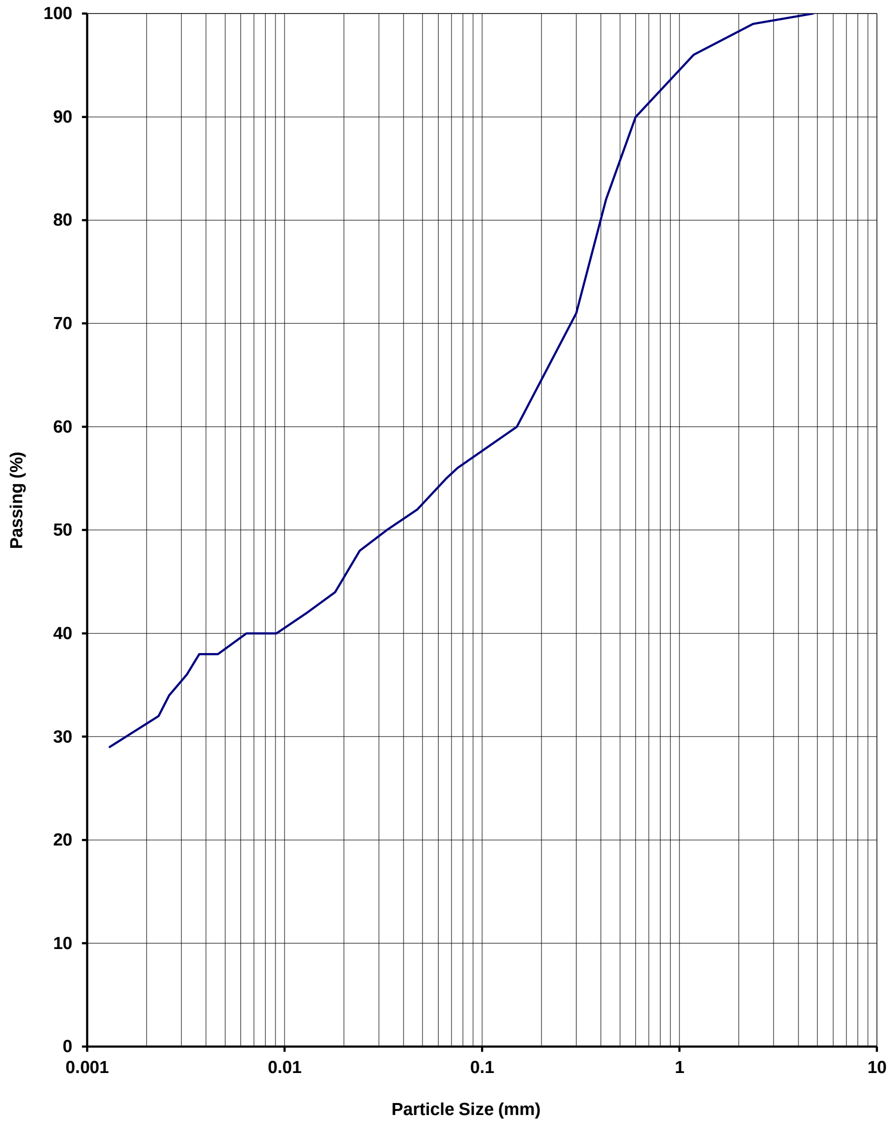
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030890-G
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/21-31/3/21
		Report Date	31/3/2021
Project	2020057 - Broadmeadow East		
Client ID	2 - 2020057_C2002	**Depth (m)**	0.50-1.00

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	99
1.18	96
0.600	90
0.425	82
0.300	71
0.150	60
0.075	56
0.066	55
0.047	52
0.033	50
0.024	48
0.018	44
0.013	42
0.0091	40
0.0064	40
0.0046	38
0.0037	38
0.0032	36
0.0026	34
0.0023	32
0.0013	29



NOTES/REMARKS: -

Moisture Content 8.7%   -2.36mm Soil Particle Density(t/m^3) 2.55

Sample/s supplied by the client

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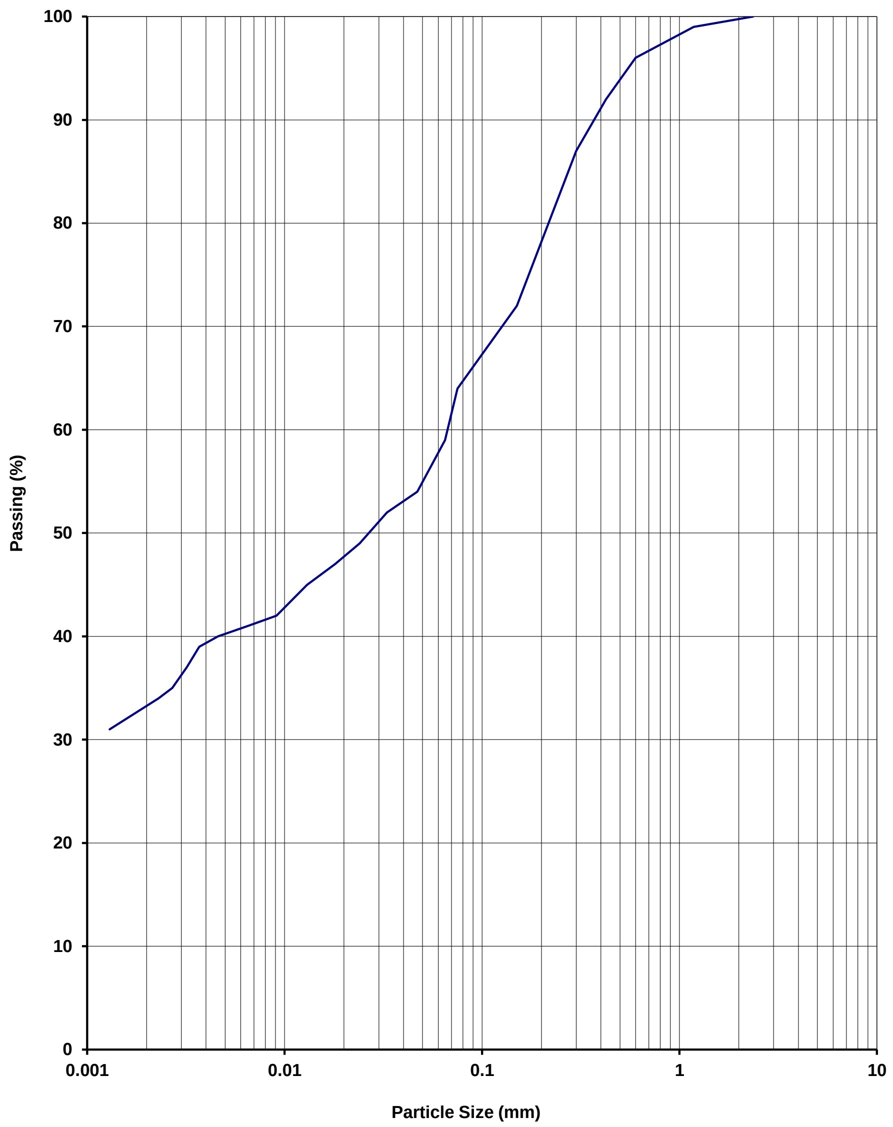
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030891-G
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/21-31/3/21
		Report Date	31/3/2021
Project	2020057 - Broadmeadow East		
Client ID	3 - 2020057_C2003	**Depth (m)**	1.00-2.00

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	100
1.18	99
0.600	96
0.425	92
0.300	87
0.150	72
0.075	64
0.065	59
0.047	54
0.033	52
0.024	49
0.018	47
0.013	45
0.0091	42
0.0065	41
0.0046	40
0.0037	39
0.0032	37
0.0027	35
0.0023	34
0.0013	31



NOTES/REMARKS: -

Moisture Content 10.3% -2.36mm Soil Particle Density(t/m^3) 2.54

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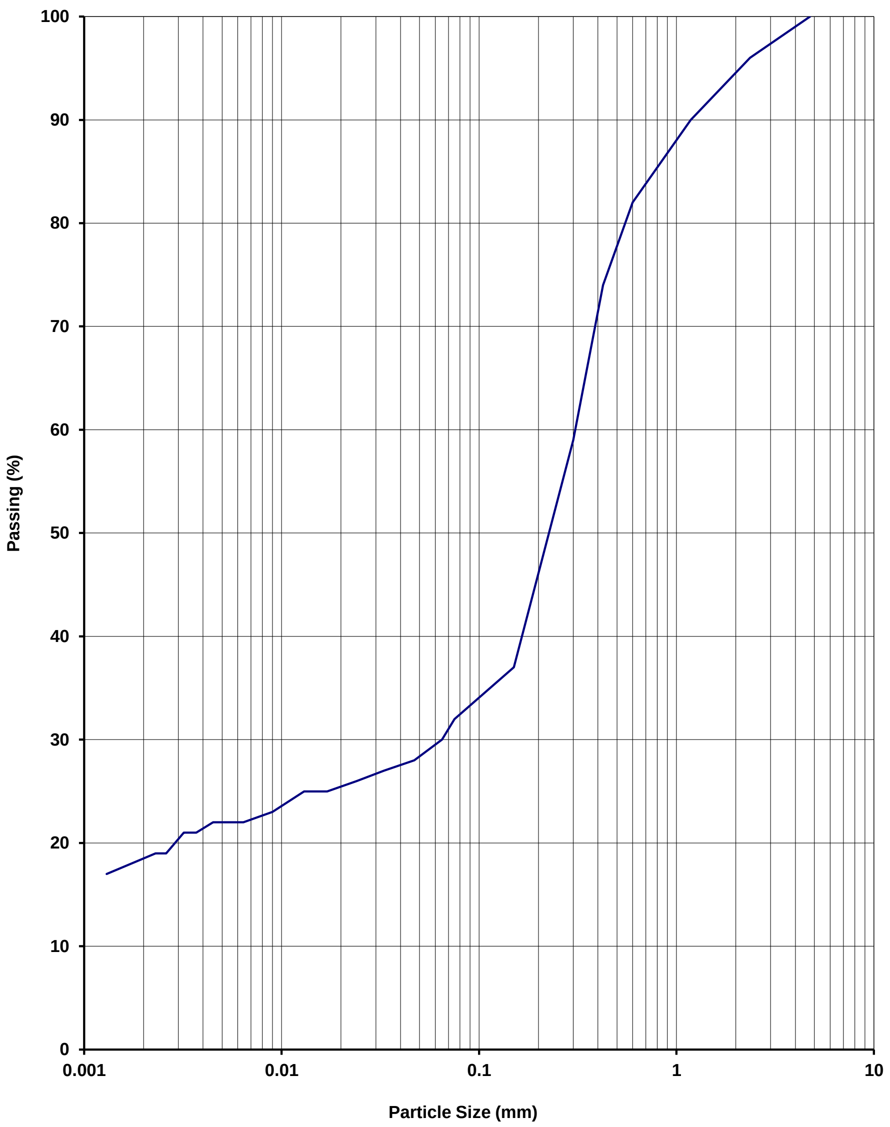
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030892-G
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/21-31/3/21
		Report Date	31/3/2021
Project	2020057 - Broadmeadow East		
Client ID	4 - 2020057_C2004	**Depth (m)**	2.00-4.00

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	96
1.18	90
0.600	82
0.425	74
0.300	59
0.150	37
0.075	32
0.065	30
0.047	28
0.033	27
0.024	26
0.017	25
0.013	25
0.009	23
0.0064	22
0.0045	22
0.0037	21
0.0032	21
0.0026	19
0.0023	19
0.0013	17



NOTES/REMARKS: -

Moisture Content 6.1%   -2.36mm Soil Particle Density(t/m^3) 2.60

Sample/s supplied by the client

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

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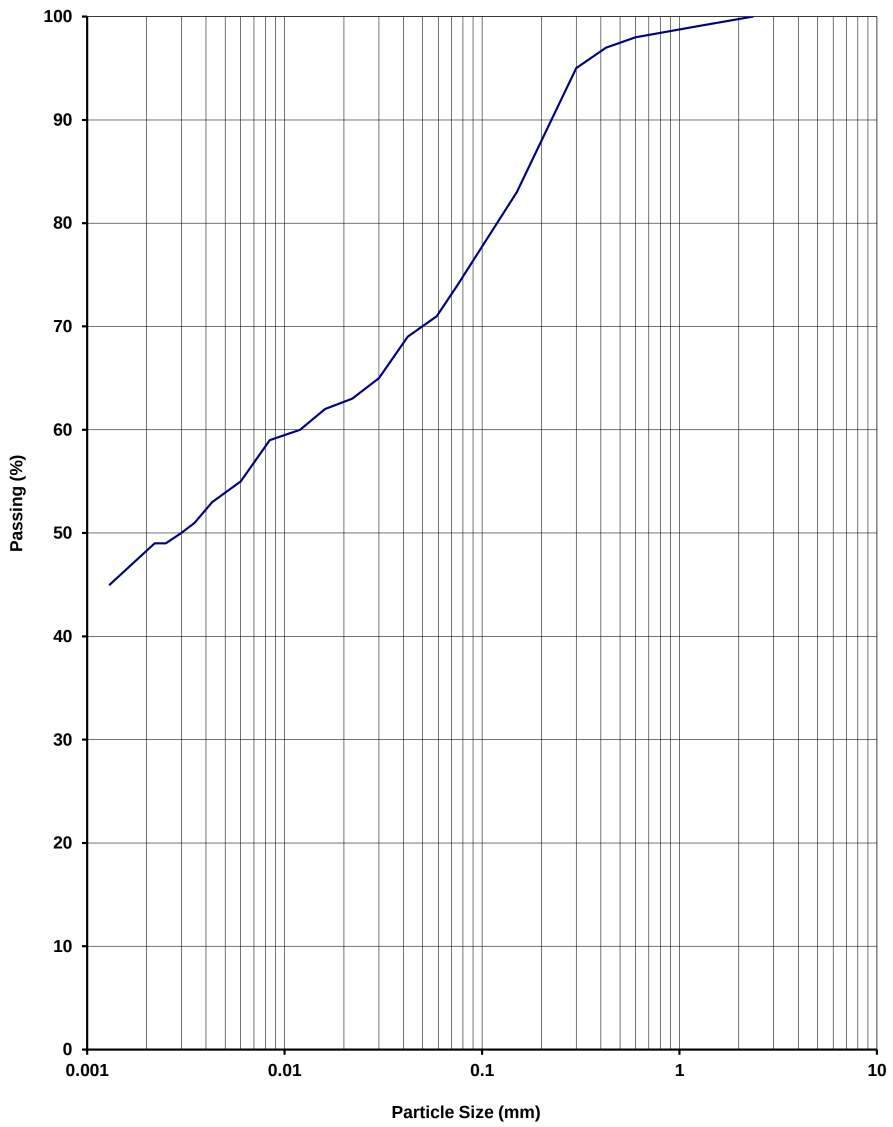
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030893-G
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/21-31/3/21
		Report Date	31/3/2021
Project	2020057 - Broadmeadow East		
Client ID	5 - 2020057_C2005	**Depth (m)**	0.00-0.50

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	100
1.18	99
0.600	98
0.425	97
0.300	95
0.150	83
0.075	74
0.059	71
0.042	69
0.03	65
0.022	63
0.016	62
0.012	60
0.0084	59
0.006	55
0.0043	53
0.0035	51
0.003	50
0.0025	49
0.0022	49
0.0013	45



NOTES/REMARKS: -

Moisture Content 13.6% -2.36mm Soil Particle Density(t/m^3) 2.54

Sample/s supplied by the client

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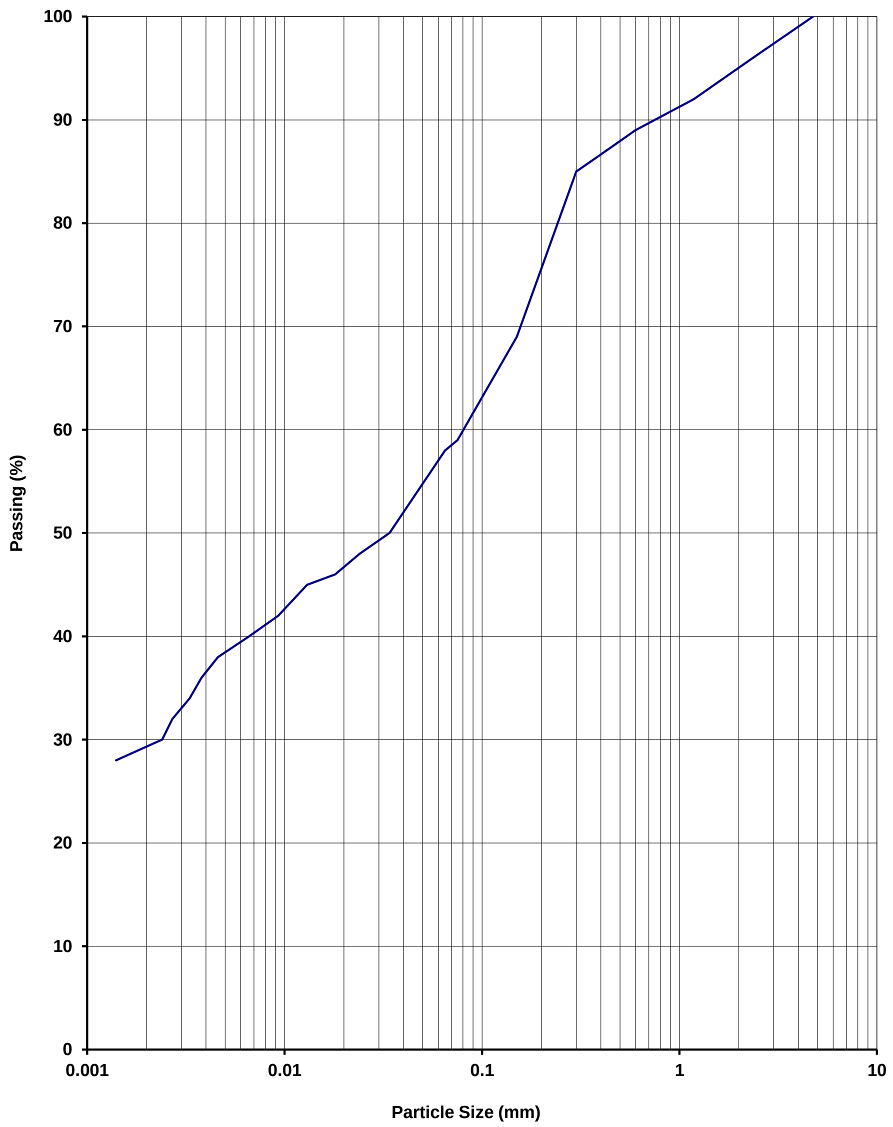
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030894-G
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/21-31/3/21
		Report Date	31/3/2021
Project	2020057 - Broadmeadow East		
Client ID	6 - 2020057_C2006	**Depth (m)**	0.50-1.00

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	96
1.18	92
0.600	89
0.425	87
0.300	85
0.150	69
0.075	59
0.065	58
0.047	54
0.034	50
0.024	48
0.018	46
0.013	45
0.0093	42
0.0066	40
0.0046	38
0.0038	36
0.0033	34
0.0027	32
0.0024	30
0.0014	28



NOTES/REMARKS: -

Moisture Content 8.4% -2.36mm Soil Particle Density(t/m^3) 2.53

Sample/s supplied by the client

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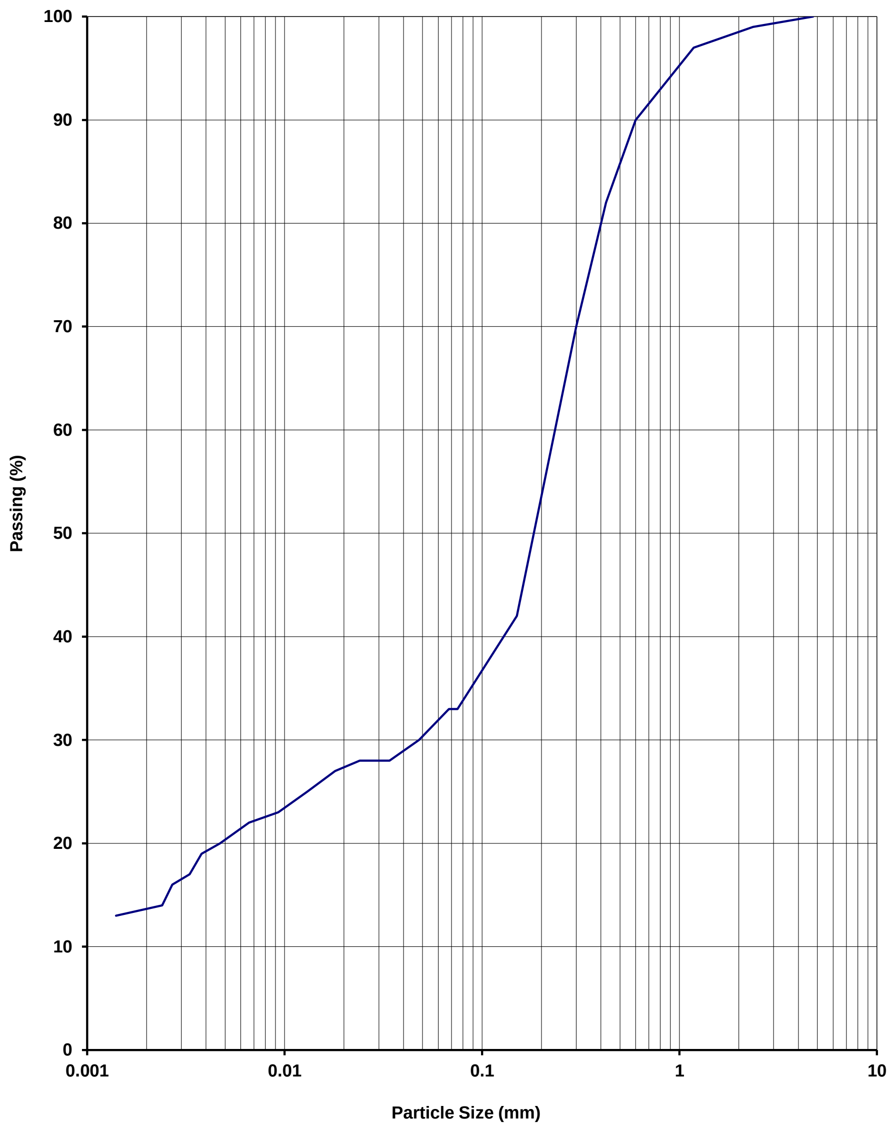
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030895-G
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/21-31/3/21
		Report Date	31/3/2021
Project	2020057 - Broadmeadow East		
Client ID	7 - 2020057_C2007	**Depth (m)**	1.00-2.00

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	99
1.18	97
0.600	90
0.425	82
0.300	70
0.150	42
0.075	33
0.068	33
0.048	30
0.034	28
0.024	28
0.018	27
0.013	25
0.0093	23
0.0066	22
0.0047	20
0.0038	19
0.0033	17
0.0027	16
0.0024	14
0.0014	13



NOTES/REMARKS: -

Moisture Content 5.6%   -2.36mm Soil Particle Density(t/m^3) 2.62

Sample/s supplied by the client

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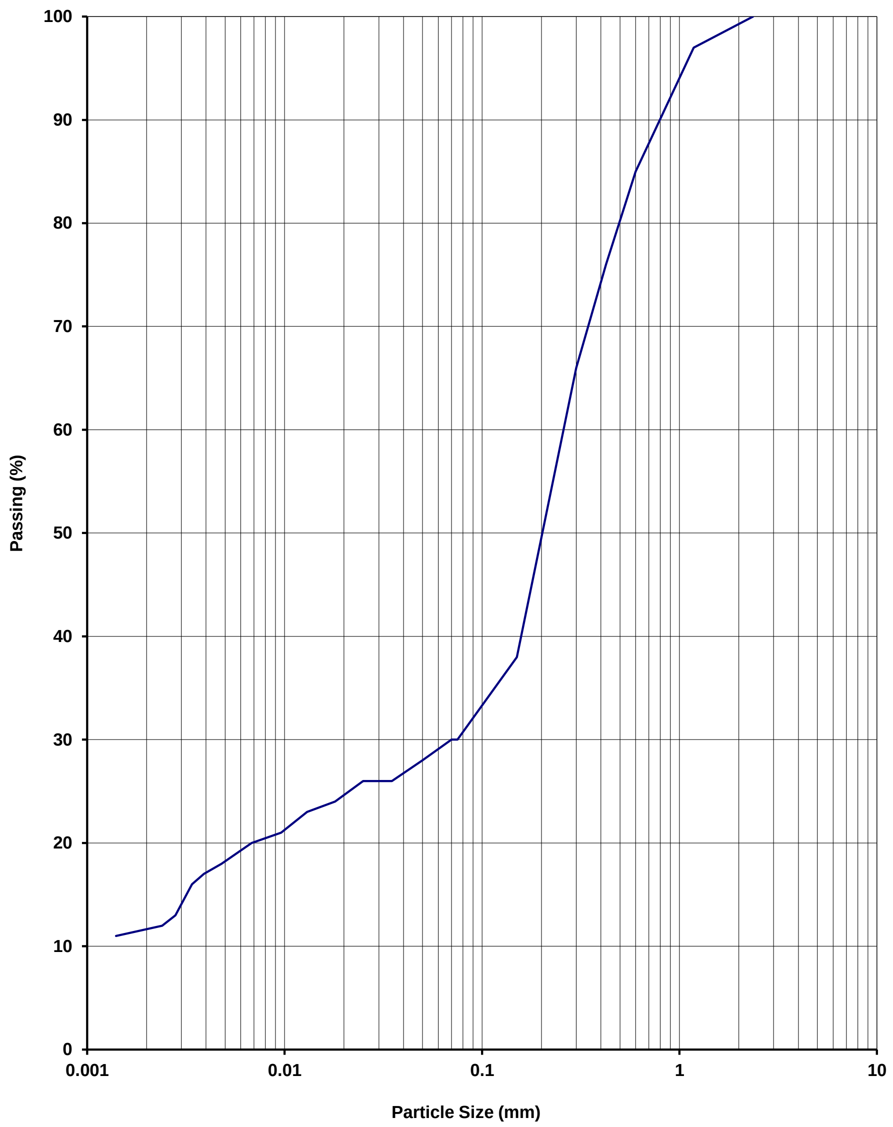
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030896-G
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/21-31/3/21
		Report Date	31/3/2021
Project	2020057 - Broadmeadow East		
Client ID	8 - 2020057_C2008	**Depth (m)**	2.00-4.00

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	100
1.18	97
0.600	85
0.425	76
0.300	66
0.150	38
0.075	30
0.07	30
0.05	28
0.035	26
0.025	26
0.018	24
0.013	23
0.0096	21
0.0068	20
0.0048	18
0.0039	17
0.0034	16
0.0028	13
0.0024	12
0.0014	11



NOTES/REMARKS: -

Moisture Content 4.6% -2.36mm Soil Particle Density(t/m^3) 2.58

Sample/s supplied by the client

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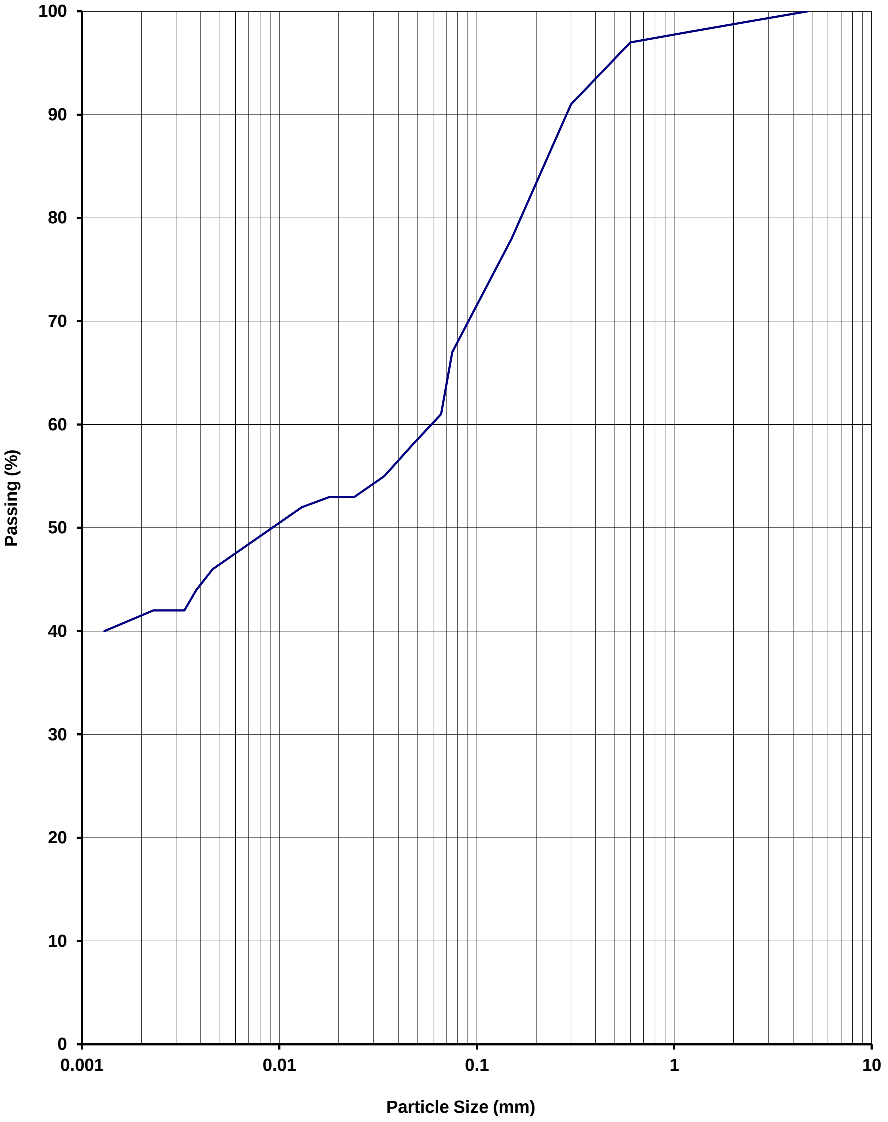
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030897-G
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/21-31/3/21
		Report Date	31/3/2021
Project	2020057 - Broadmeadow East		
Client ID	9 - 2020057_C2009	**Depth (m)**	0.00-0.50

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	99
1.18	98
0.600	97
0.425	94
0.300	91
0.150	78
0.075	67
0.066	61
0.047	58
0.034	55
0.024	53
0.018	53
0.013	52
0.0092	50
0.0065	48
0.0046	46
0.0038	44
0.0033	42
0.0027	42
0.0023	42
0.0013	40



NOTES/REMARKS: -

Moisture Content 9.4% -2.36mm Soil Particle Density(t/m^3) 2.54

Sample/s supplied by the client

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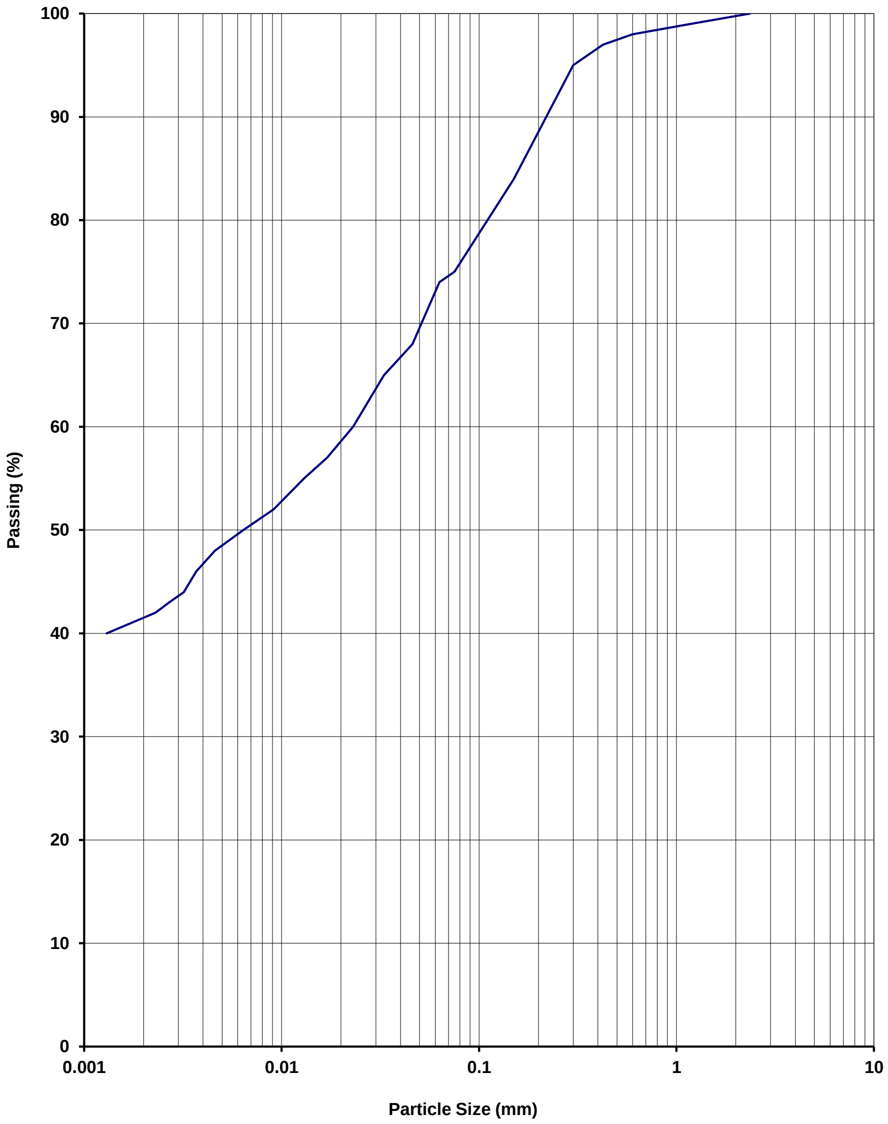
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030898-G
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/21-31/3/21
		Report Date	31/3/2021
Project	2020057 - Broadmeadow East		
Client ID	10 - 2020057_C2010	**Depth (m)**	1.50-1.00

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	100
1.18	99
0.600	98
0.425	97
0.300	95
0.150	84
0.075	75
0.063	74
0.046	68
0.033	65
0.023	60
0.017	57
0.013	55
0.0091	52
0.0064	50
0.0046	48
0.0037	46
0.0032	44
0.0027	43
0.0023	42
0.0013	40



NOTES/REMARKS: -

Moisture Content 10.4% -2.36mm Soil Particle Density(t/m^3) 2.54

Sample/s supplied by the client

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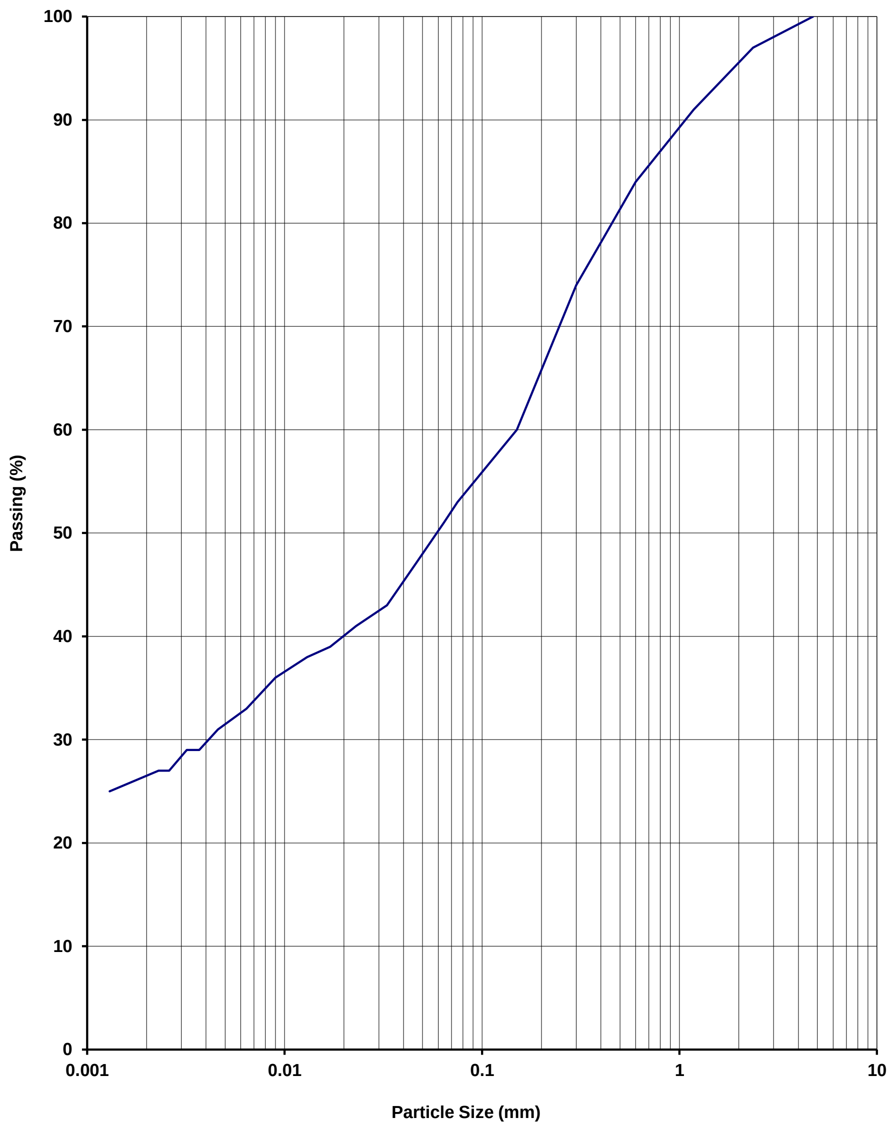
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030899-G
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/21-31/3/21
		Report Date	31/3/2021
Project	2020057 - Broadmeadow East		
Client ID	11 - 2020057_C2011	**Depth (m)**	1.00-2.00

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	97
1.18	91
0.600	84
0.425	79
0.300	74
0.150	60
0.075	53
0.064	51
0.046	47
0.033	43
0.023	41
0.017	39
0.013	38
0.009	36
0.0064	33
0.0046	31
0.0037	29
0.0032	29
0.0026	27
0.0023	27
0.0013	25



NOTES/REMARKS: -

Moisture Content 9% -2.36mm Soil Particle Density(t/m^3) 2.63

Sample/s supplied by the client

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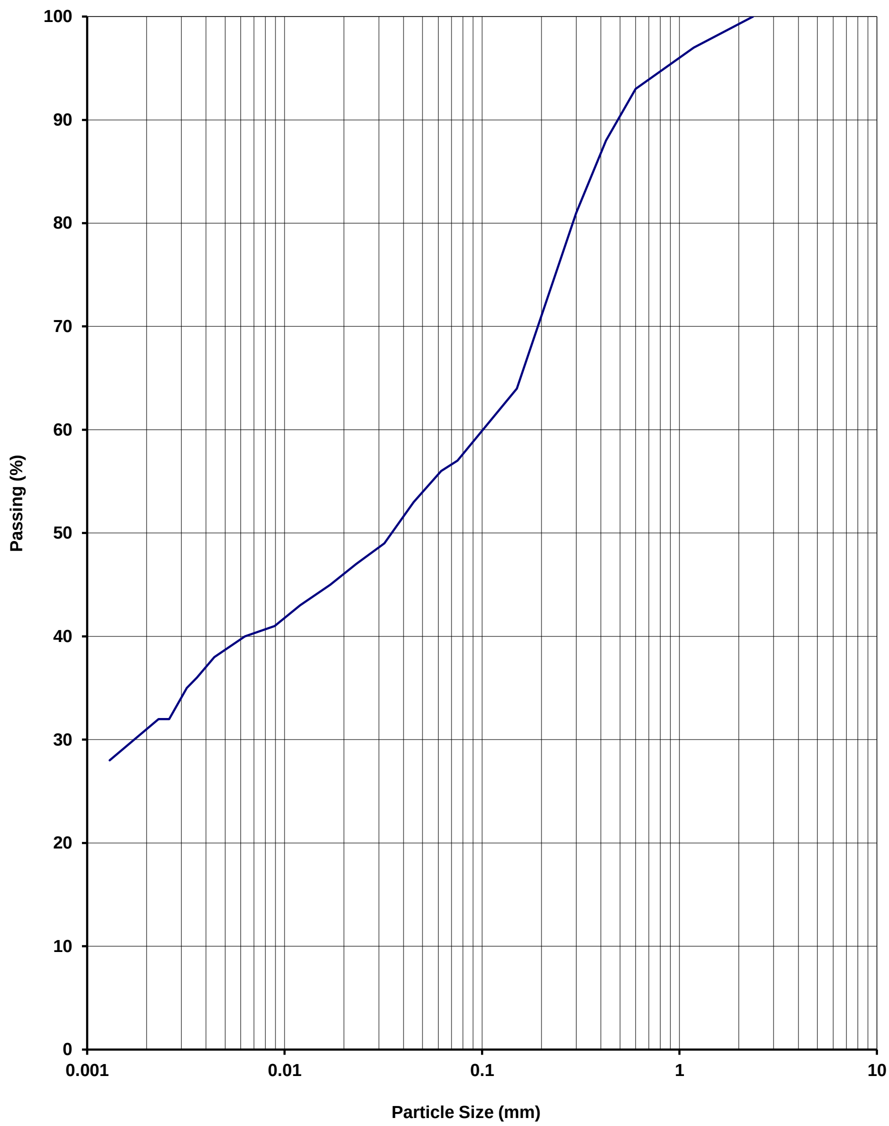
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030900-G
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/21-31/3/21
		Report Date	31/3/2021
Project	2020057 - Broadmeadow East		
Client ID	12 - 2020057_C2012	**Depth (m)**	2.00-4.00

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	100
1.18	97
0.600	93
0.425	88
0.300	81
0.150	64
0.075	57
0.062	56
0.045	53
0.032	49
0.023	47
0.017	45
0.012	43
0.0089	41
0.0063	40
0.0044	38
0.0036	36
0.0032	35
0.0026	32
0.0023	32
0.0013	28



NOTES/REMARKS: -

Moisture Content 10.8% -2.36mm Soil Particle Density(t/m^3) 2.61

Sample/s supplied by the client

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9.5.2 Shrink swell

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SHRINK SWELL INDEX TEST REPORT

Test Method AS 1289 7.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030901-ISS
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	29/3/21-7/4/21
		Report Date	8/04/2021
Project	2020057 - Broadmeadow East		
Description	Sandy CLAY - brown		

Sample No.	21030901
Client ID	13 - 2020057_C2013
Depth (m)	0.00-0.50

RESULTS OF TESTING

SWELL SPECIMEN

Swell Pressure (kPa) *	-
Wet Density (t/m^3)	1.76
Initial Moisture Content (%)	16.4
Final Moisture Content (%)	24.0
Swell (%)	**0.3**

SHRINKAGE SPECIMEN

Estimated Inert Inclusions (%)	0
Extent of Crumbling	Nil
Extent of Cracking	Nil
Moisture (%)	16.5
Shrinkage (%)	**2.0**

SHRINK SWELL INDEX (Iss) (%)	**1.2**

Notes/Remarks: The above specimen was remoulded at 85% Standard Dry Density and at Optimum Moisture Content as advised by the client (-2.36mm material tested)

Sample/s supplied by client

Authorised Signatory

C. Park

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SHRINK SWELL INDEX TEST REPORT

Test Method AS 1289 7.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030902-ISS
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	29/3/21-7/4/21
		Report Date	8/04/2021
Project	2020057 - Broadmeadow East		
Description	Sandy CLAY - brown		

Sample No.	21030902
Client ID	14 - 2020057_C2014
Depth (m)	0.50-1.00

RESULTS OF TESTING

SWELL SPECIMEN

Swell Pressure (kPa) *	-
Wet Density (t/m^3)	1.78
Initial Moisture Content (%)	15.8
Final Moisture Content (%)	23.2
Swell (%)	**0.3**

SHRINKAGE SPECIMEN

Estimated Inert Inclusions (%)	0
Extent of Crumbling	Nil
Extent of Cracking	Nil
Moisture (%)	15.9
Shrinkage (%)	**1.7**

SHRINK SWELL INDEX (Iss) (%)	**1.0**

Notes/Remarks: The above specimen was remoulded at 85% Standard Dry Density and at Optimum Moisture Content as advised by the client (-2.36mm material tested)

Sample/s supplied by client

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Authorised Signatory

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SHRINK SWELL INDEX TEST REPORT

Test Method AS 1289 7.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030903-ISS
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	29/3/21-7/4/21
		Report Date	8/04/2021
Project	2020057 - Broadmeadow East		
Description	Sandy CLAY - brown		

Sample No.	21030903
Client ID	15 - 2020057_C2015
Depth (m)	1.00-2.00

RESULTS OF TESTING

SWELL SPECIMEN

Swell Pressure (kPa) *	-
Wet Density (t/m^3)	1.82
Initial Moisture Content (%)	13.7
Final Moisture Content (%)	20.5
Swell (%)	**0.1**

SHRINKAGE SPECIMEN

Estimated Inert Inclusions (%)	0
Extent of Crumbling	Nil
Extent of Cracking	Nil
Moisture (%)	13.6
Shrinkage (%)	**0.4**

SHRINK SWELL INDEX (Iss) (%)	**0.2**

Notes/Remarks: The above specimen was remoulded at 85% Standard Dry Density and at Optimum Moisture Content as advised by the client (-2.36mm material tested)

Sample/s supplied by client

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Authorised Signatory

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SHRINK SWELL INDEX TEST REPORT

Test Method AS 1289 7.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030904-ISS
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	29/3/21-7/4/21
		Report Date	8/04/2021
Project	2020057 - Broadmeadow East		
Description	Clayey SAND- brown		

Sample No.	21030904
Client ID	16 - 2020057_C2016
Depth (m)	2.00-4.00

RESULTS OF TESTING

SWELL SPECIMEN

Swell Pressure (kPa) *	-
Wet Density (t/m^3)	1.83
Initial Moisture Content (%)	12.7
Final Moisture Content (%)	18.9
Swell (%)	**0.1**

SHRINKAGE SPECIMEN

Estimated Inert Inclusions (%)	0
Extent of Crumbling	Nil
Extent of Cracking	Nil
Moisture (%)	12.7
Shrinkage (%)	**0.1**

SHRINK SWELL INDEX (Iss) (%)	**0.1**

Notes/Remarks: The above specimen was remoulded at 85% Standard Dry Density and at Optimum Moisture Content as advised by the client (-2.36mm material tested)

Sample/s supplied by client

Authorised Signatory

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9.5.3 Permeability

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PERMEABILITY BY FALLING HEAD TEST REPORT

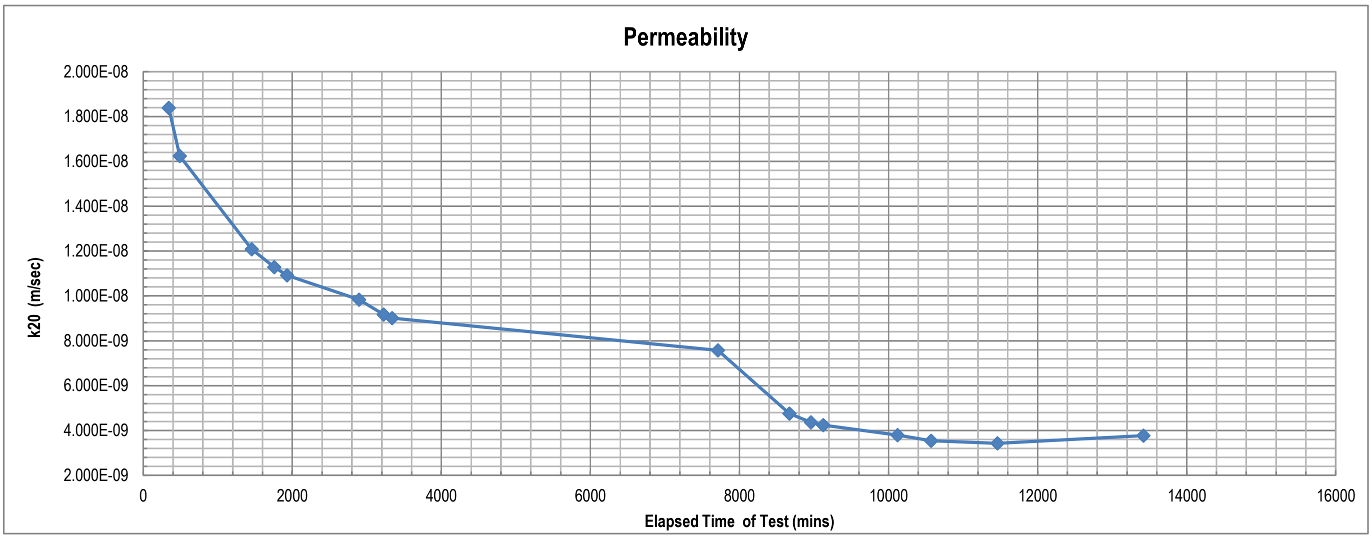
Test Method AS 1289 6.7.2, 5.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030902-FHPT
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	16/3/21-31/3/21
		Report Date	31/03/2021
Project	2020057 - Broadmeadow East		
Client ID	14 - 2020057_C2014	**Depth (m)**	0.50-1.00
Description	Sandy CLAY - brown	**Sample Type**	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	**AS1289.5.1.1 - Standard Compaction**		
Maximum Dry Density (t/m^3)	**1.81**	Hydraulic Gradient	**9.5**
Optimum Moisture Content (%)	**16.1**	Surcharge (kPa)	**2.9**
Placement Moisture Content (%)	**16.1**	Head Pressure Applied (kPa)	**10.79**
Moisture Ratio (%)	**100.0**	Water Type	**Deaerated**
Placement Wet Density (t/m^3)	**1.78**	Percentage Material Retained/Sieve Size (mm)	**0 % /9.5 mm**
Density Ratio (%)	**84.9**	Sample Height and Diameter (mm)	**116 / 101.47 mm**

PERMEABILITY $k_{(20)} = 3.8 \times 10^{-09}$ **(m/sec)**



Remarks: The above specimen was remoulded at 85% Standard Dry Density and at Optimum Moisture Content as advised by the client

Sample/s supplied by client

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The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

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Authorised Signatory

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PERMEABILITY BY FALLING HEAD TEST REPORT

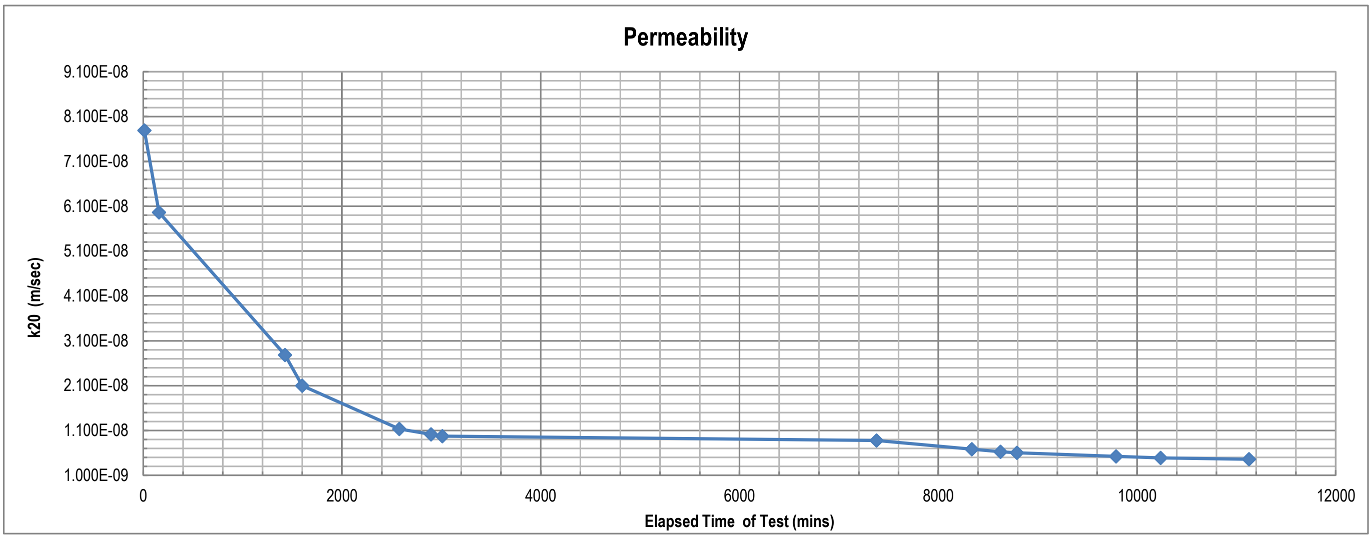
Test Method AS 1289 6.7.2, 5.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030903-FHPT
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	16/3/21-31/3/21
		Report Date	31/03/2021
Project	2020057 - Broadmeadow East		
Client ID	15 - 2020057_C2015	**Depth (m)**	1.00-2.00
Description	Sandy CLAY - brown	**Sample Type**	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	**AS1289.5.1.1 - Standard Compaction**		
Maximum Dry Density (t/m^3)	**1.88**	Hydraulic Gradient	**9.5**
Optimum Moisture Content (%)	**14.0**	Surcharge (kPa)	**2.9**
Placement Moisture Content (%)	**14.4**	Head Pressure Applied (kPa)	**10.79**
Moisture Ratio (%)	**103.0**	Water Type	**Deaerated**
Placement Wet Density (t/m^3)	**1.82**	Percentage Material Retained/Sieve Size (mm)	**0 % /9.5 mm**
Density Ratio (%)	**84.7**	Sample Height and Diameter (mm)	**116.28 / 100.91 mm**

PERMEABILITY $k_{(20)} = 4.6 \times 10^{-09}$ **(m/sec)**



Remarks: The above specimen was remoulded at 85% Standard Dry Density and at Optimum Moisture Content as advised by the client

Sample/s supplied by client

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Authorised Signatory

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PERMEABILITY BY FALLING HEAD TEST REPORT

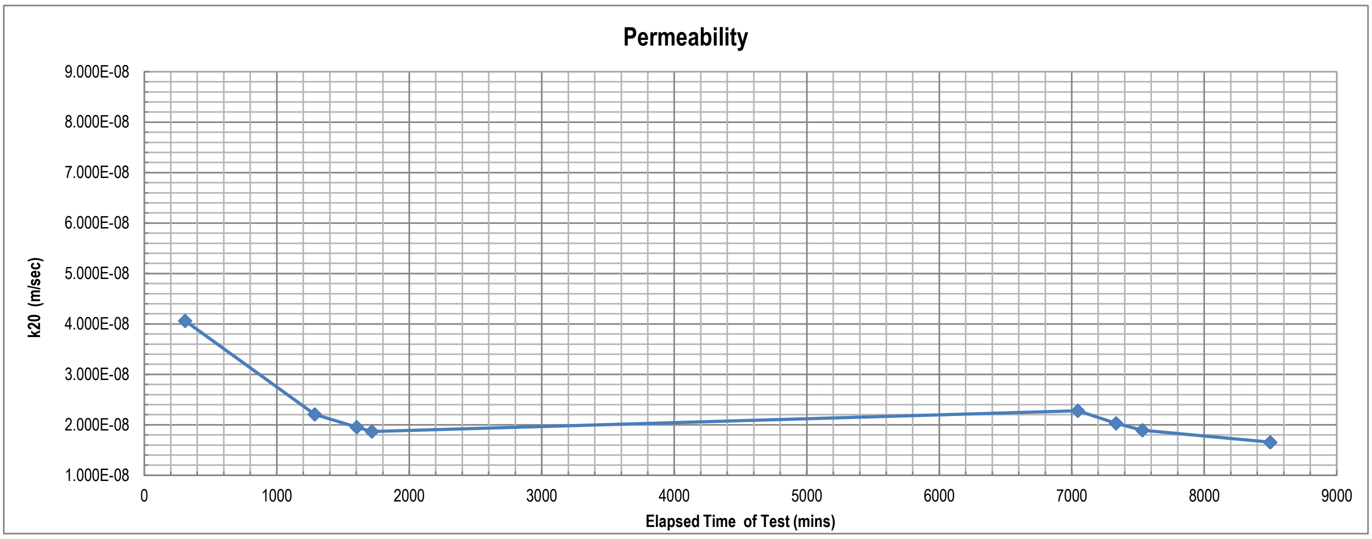
Test Method AS 1289 6.7.2, 5.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030904-FHPT
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	16/3/2021-31/3/2021
		Report Date	31/03/2021
Project	2020057 - Broadmeadow East		
Client ID	16 - 2020057_C2016	**Depth (m)**	2.00-4.00
Description	Clayey SAND - brown	**Sample Type**	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	**AS1289.5.1.1 - Standard Compaction**		
Maximum Dry Density (t/m^3)	**1.91**	Hydraulic Gradient	**9.5**
Optimum Moisture Content (%)	**12.9**	Surcharge (kPa)	**2.9**
Placement Moisture Content (%)	**12.8**	Head Pressure Applied (kPa)	**10.79**
Moisture Ratio (%)	**99.0**	Water Type	**Deaerated**
Placement Wet Density (t/m^3)	**1.83**	Percentage Material Retained/Sieve Size (mm)	**0 % /9.5 mm**
Density Ratio (%)	**85.1**	Sample Height and Diameter (mm)	**116.2 / 101.4 mm**

PERMEABILITY $k_{(20)} = 1.7 \times 10^{-08}$ **(m/sec)**



Remarks: The above specimen was remoulded at 85% Standard Dry Density and at Optimum Moisture Content as advised by the client

Sample/s supplied by client

 REP06301

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PERMEABILITY BY FALLING HEAD TEST REPORT

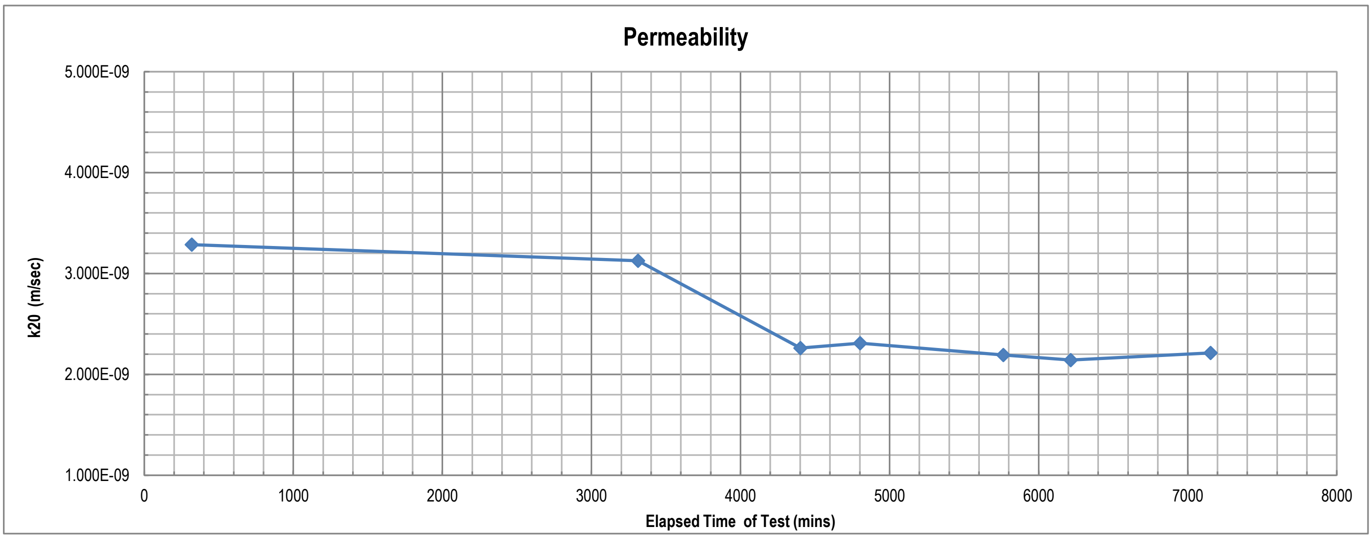
Test Method AS 1289 6.7.2, 5.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030901-FHPT
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/3/2021-31/3/2021
		Report Date	31/03/2021
Project	2020057 - Broadmeadow East		
Client ID	13 - 2020057_C2013	**Depth (m)**	0.00-0.50
Description	CLAY - brown	**Sample Type**	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	**AS1289.5.1.1 - Standard Compaction**		
Maximum Dry Density (t/m^3)	**1.77**	Hydraulic Gradient	**9.4**
Optimum Moisture Content (%)	**16.8**	Surcharge (kPa)	**2.9**
Placement Moisture Content (%)	**16.5**	Head Pressure Applied (kPa)	**10.79**
Moisture Ratio (%)	**98.4**	Water Type	**Deaerated**
Placement Wet Density (t/m^3)	**1.76**	Percentage Material Retained/Sieve Size (mm)	**0 % /9.5 mm**
Density Ratio (%)	**85.2**	Sample Height and Diameter (mm)	**116.43 / 101.47 mm**

PERMEABILITY $k_{(20)} = 2.2 \times 10^{-09}$ **(m/sec)**



Remarks: The above specimen was remoulded at 85% Standard Dry Density and at Optimum Moisture Content as advised by the client

Sample/s supplied by client

9.5.4 Pinhole dispersion

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PINHOLE DISPERSION TEST REPORT

Test Method: AS 1289 3.8.3

Client	RGS Environmental Pty Ltd	**Report No.**	21030904-PHD
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/03/2021
		Report Date	23/03/2021
Project	2020057 - Broadmeadow East		

Sample No.	21030904		
Client ID	16 - 2020057_C2016		
Depth (m)	2.00-4.00		
Description	Clayey SAND - brown		
Method of Moisture Determination for Remoulding	Optimum Moisture		
Initial Moisture Content (%)	7.3		
Placement Wet Density (t/m³)	1.84		
Placement Moisture Content (%)	13.1		
Density Ratio (%)	85		
Variation from Optimum Moisture Content (%)	0		
Curing Time (Days)	1		
Source of Water	Potable		
Rate of Flow at end of test (mL/sec)	0.09		
Hole Reformed at 50mm Head Height	No		
PINHOLE DISPERSION CLASSIFICATION: DESIGNATION	D2		
DESCRIPTION	Dispersive		

NOTES/REMARKS: The above specimen was remoulded at 85% Standard Compaction as advised by the client

Sample/s supplied by the client

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PINHOLE DISPERSION TEST REPORT

Test Method: AS 1289 3.8.3

Client	RGS Environmental Pty Ltd	**Report No.**	21030901-PHD
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	18/03/2021
		Report Date	23/03/2021
Project	2020057 - Broadmeadow East		

Sample No.	21030901	21030902	21030903
Client ID	13 - 2020057_C2013	14 - 2020057_C2014	15 - 2020057_C2015
Depth (m)	0.00-0.50	0.50-1.00	1.00-2.00
Description	CLAY - brown	CLAY - brown	Sandy CLAY - brown
Method of Moisture Determination for Remoulding	Optimum Moisture	Optimum Moisture	Optimum Moisture
Initial Moisture Content (%)	11.4	10.7	9.1
Placement Wet Density (t/m³)	1.76	1.79	1.82
Placement Moisture Content (%)	17.2	16.3	14.1
Density Ratio (%)	85	85	85
Variation from Optimum Moisture Content (%)	0	0	0
Curing Time (Days)	1	1	1
Source of Water	Potable	Potable	Potable
Rate of Flow at end of test (mL/sec)	2.33	2.52	2.28
Hole Reformed at 50mm Head Height	No	No	No
PINHOLE DISPERSION CLASSIFICATION: DESIGNATION	ND2	ND2	ND2
DESCRIPTION	Completely Erosion Resistant	Completely Erosion Resistant	Completely Erosion Resistant

NOTES/REMARKS: The above specimens were remoulded at 85% Standard Compaction as advised by the client

Sample/s supplied by the client

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9.5.5 Emerson Class

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EMERSON CLASS NUMBER TEST REPORT

Test Method: AS 1289 3.8.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030889-EM
		Workorder No.	8377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-31/3/21
		Report Date	31/03/2021
Project	2020057 - Broadmeadow East		

Sample No.	21030889	21030890	21030891	21030892	21030893	21030894	21030895
Client ID	1 - 2020057_C2 001	2 - 2020057_C2 002	3 - 2020057_C2 003	4 - 2020057_C2 004	5 - 2020057_C2 005	6 - 2020057_C2 006	7 - 2020057_C2 007
Depth (m)	0.00-0.50	0.50-1.00	1.00-2.00	2.00-4.00	0.00-0.50	0.50-1.00	1.00-2.00
Description	Sandy CLAY - brown	Sandy CLAY - brown	Sandy CLAY - brown	Clayey SAND - brown	Sandy CLAY - brown	Sandy CLAY - brown	Clayey SAND - brown
Emerson Class Number	**2**	**2**	**2**	**2**	**4**	**4**	**4**

Sample No.	21030896	21030897	21030898	21030899	21030900	-	-
Client ID	8 - 2020057_C2 008	9 - 2020057_C2 009	10 - 2020057_C2 010	11 - 2020057_C2 011	12 - 2020057_C2 012	-	-
Depth (m)	2.00-4.00	0.00-0.50	1.50-1.00	1.00-2.00	2.00-4.00	-	-
Description	Clayey SAND - brown	Sandy CLAY - brown	Sandy CLAY - brown	Sandy CLAY - brown	Sandy CLAY - brown	-	-
Emerson Class Number	**4**	**3**	**3**	**2**	**2**	**-**	**-**

Sample No.	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Description	-	-	-	-	-	-	-
Emerson Class Number	**-**	**-**	**-**	**-**	**-**	**-**	**-**

NOTES/REMARKS:

Sample/s supplied by the client   Tested with water at °C

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9.5.6 Point load

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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	RGS Environmental Pty Ltd	**Report No.**	21030906-PL
		Workorder No.	0008377
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	12/03/2021
		Report Date	16/03/2021
Project	2020057 - Broadmeadow East		

Sample No.	21030906	21030907	21030912	21030923	21030926	21030906	21030907
Client ID	2 - 202057_1021	3 - 202057_1022	8 - 202057_1063	19 - 202057_1220	22 - 202057_1223	2 - 202057_1021	3 - 202057_1022
Depth (m)	20.77-20.93	21.43-21.61	45.45-45.56	58.34-58.45	61.58-61.73	20.77-20.93	21.43-21.61
I_s (MPa)	2.33	1.21	0.70	0.70	0.38	2.25	1.02
$I_{s(50)}$ (MPa)	2.73	1.53	0.78	0.80	0.40	2.90	1.39
Load Direction	Axial	Axial	Axial	Axial	Axial	Diametral	Irregular Lump

Sample No.	21030912	21030923	21030926				
Client ID	8 - 202057_1063	19 - 202057_1220	22 - 202057_1223				
Depth (m)	45.45-45.56	58.34-58.45	61.58-61.73				
I_s (MPa)	0.08	0.35	0.05				
$I_{s(50)}$ (MPa)	0.10	0.46	0.06				
Load Direction	Diametral	Diametral	Diametral				

NOTES/REMARKS: Tested as received + Irregular Lump

Sample/s supplied by the client

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Authorised Signatory

N. Maddison

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Laboratory No. 9926

9.6 Attachment F: Levay and Co XRD report

Job No.
L&C-21-067

REPORT

QXRD Analysis of Four Samples

RGS Job No. 2020057 – Broadmeadows East
Purchase Order No.2021007

Prepared for:

Dr. Alan M. Robertson,
Director – Principal Geochemist,
RGS Environmental Pty. Ltd.,
123 Wynne Street,
Sunnybank Hills. QLD. 4109.

Prepared by:

George Levay,
Levay & Co. Environmental Services,
Unit 8, 62 – 64 West Avenue,
Edinburgh. SA. 5111.

Date: 8th April, 2021

Introduction

Levay & Co. Environmental Services received four samples (RGS Job No. 2020057 – Broadmeadows East) from RGS Environmental on 26th March, 2021 to determine the mineralogical content by (semi-) quantitative x-ray diffraction (QXRD) analysis. The sample details are provided in the table below.

Table 1. List of samples received for QXRD analysis

RGS Sample ID.	Levay & Co. ID.	Sample Description
2020057 – C2013	21-067-01	Soil
2020057 – C2014	21-067-02	Soil
2020057 – C2015	21-067-03	Soil
2020057 – C2016	21-067-04	Soil

(Semi) - Quantitative X-Ray Diffraction (QXRD)

X-ray diffraction traces were obtained from the samples with a Panalytical Aeris Powder Diffractometer. Operating conditions were 40kV/15mA, Fe Kß filter, step scan 0.01/29 secs˚2ϴ at, 1/2˚ divergence and a 1.0˚ ant-scatter slit. Scan range was 5° to 90° 2ϴ.

Additional XRD scans have been obtained from sedimented air dried and glycol treated samples. Phases were identified by computer search/match of the ICDD PDF4 Minerals 2020 Database and the USGS Clay Identification "Flowsheet". Quantitative results were determined with full pattern Rietveld refinement software.

Results

The results from QXRD analysis of these samples are shown in Table 2 below. Mineralisation includes silicates (quartz, kaolinite and albite), iron-oxides (goethite) and carbonates (calcite) as the dominant phases. The samples also contain other silicates (microcline, smectite, illite and chlorite).

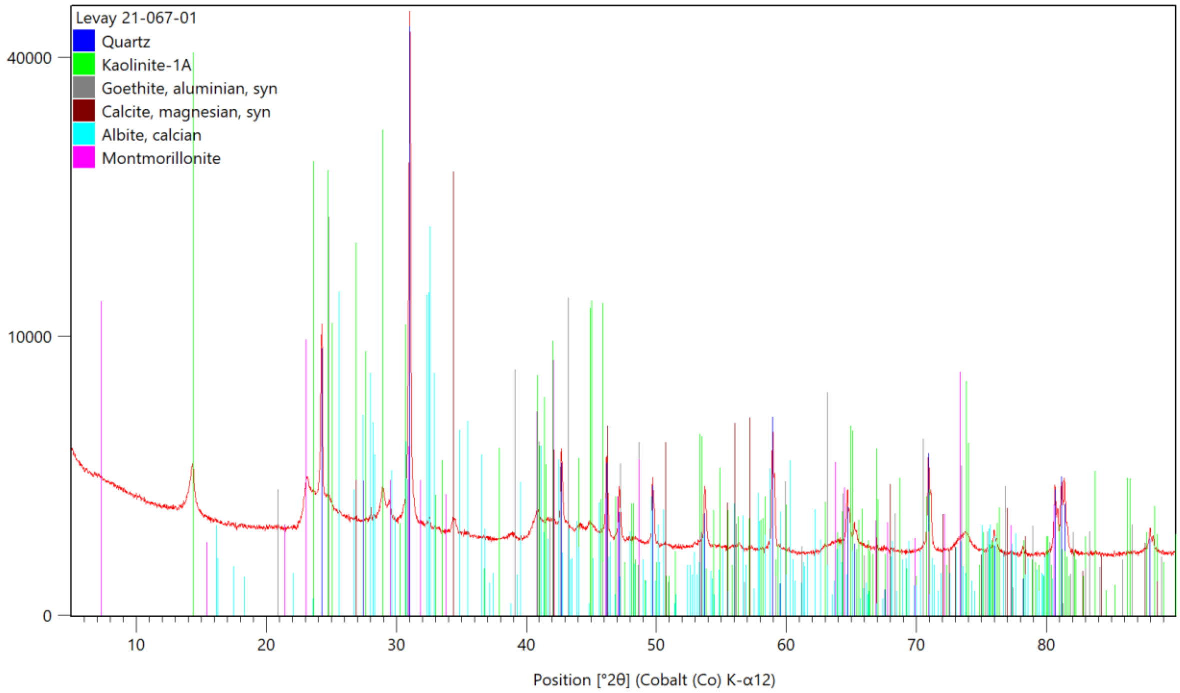
Note: The smectite (montmorillonite) content is estimated to be relatively low with the (001) peaks barely discernible on the traces obtained from the random powder sample mounts, however clay properties such as drying shrinkage will also be influenced by the poorly ordered character of the kaolinite and goethite present in the samples provided.

Table 2 QXRD results

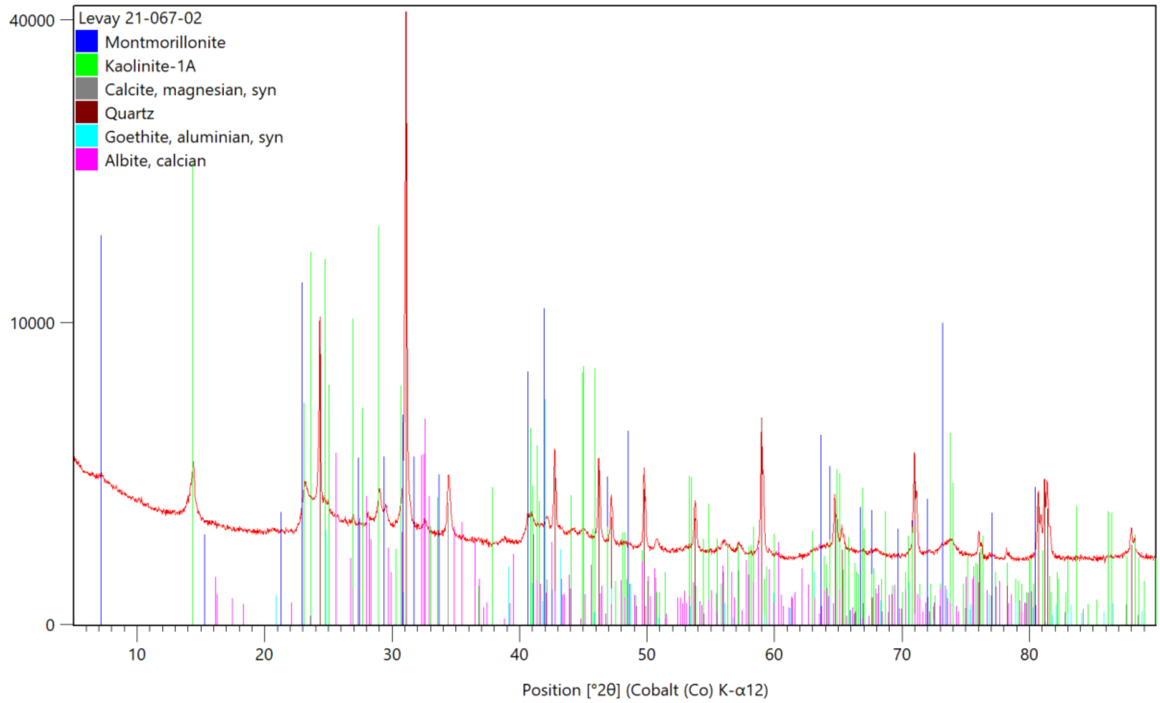
Phase	2020057-C2013 Weight %[1]	2020057-C2014 Weight %[1]	2020057-C2015 Weight %[1]	2020057-C2016 Weight %[1]
Quartz	57.9	56.2	56.8	50.8
Kaolinite – poorly ordered*	27.6	25.2	23.5	21.4
Goethite – poorly ordered*	6.6	6.9	6.4	5.9
Albite	2.6	3	4.8	8.4
Calcite	0.6	3.1	2.4	5.2
Microcline	2.7	2.7	2.7	2.6
Smectite (montmorillonite) – poorly ordered*	1.4	1.6	1.5	1.4
Chlorite	0.1	0.9	1.3	3.5
Illite	0.5	0.4	0.6	0.8
Ankerite	ND[2]	ND[2]	ND[2]	ND[2]
Marcasite	ND[2]	ND[2]	ND[2]	ND[2]
Siderite	ND[2]	ND[2]	ND[2]	ND[2]
Pyrite	ND[2]	ND[2]	ND[2]	ND[2]

1 Semiquantitative Detection limit ~0.2 wt.%
2 ND = Non Detectable
* Broad and poorly defined peaks

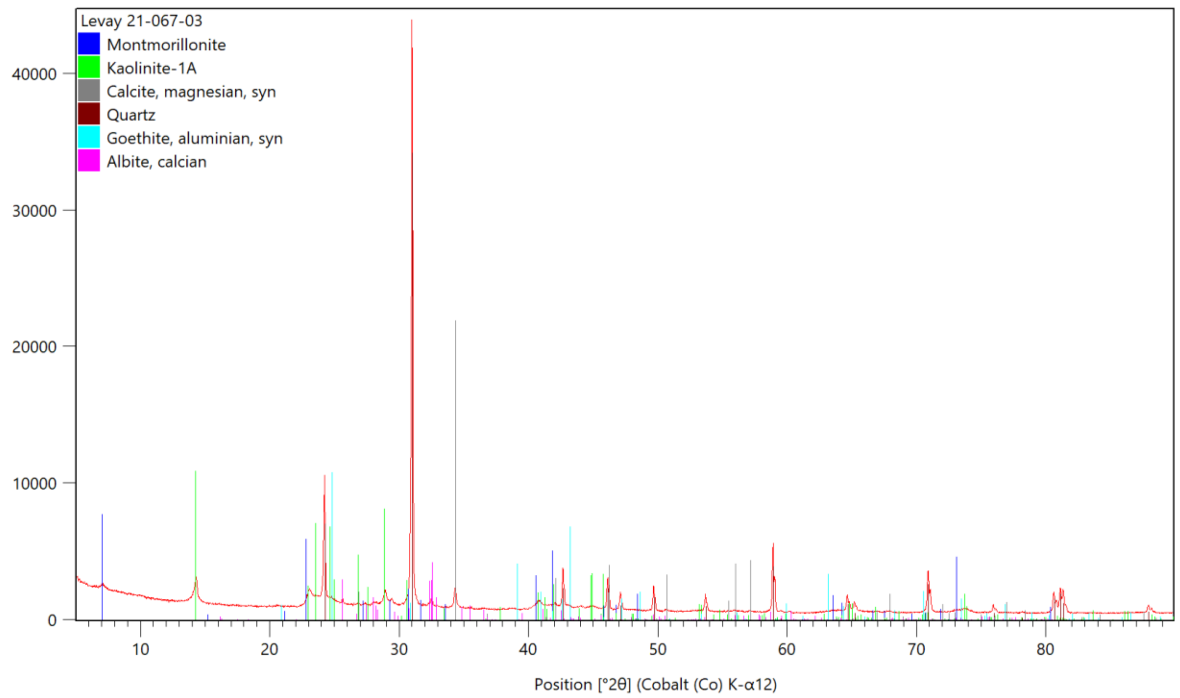
Results Graphical – Phase ID



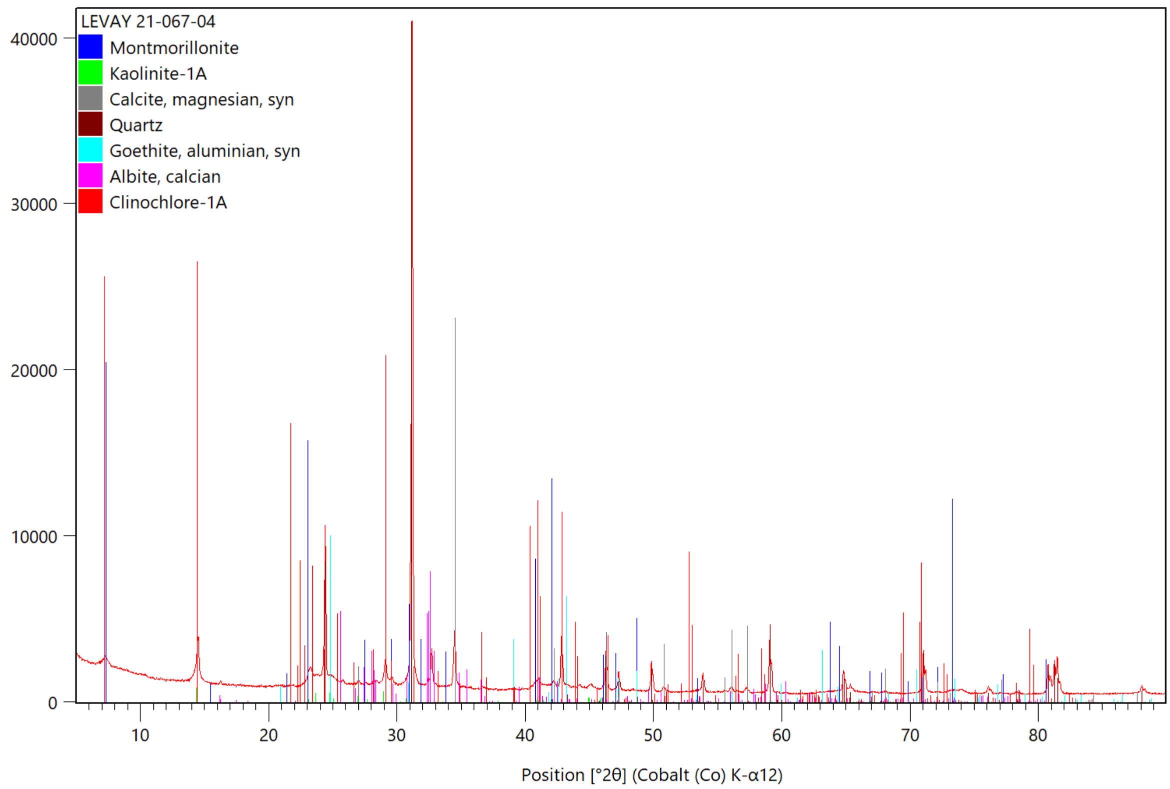
XRD trace obtained from #2020057-C2013 showing peaks indexed for the main phases identified.



XRD trace obtained from #2020057-C2014 showing peaks indexed for the main phases identified.

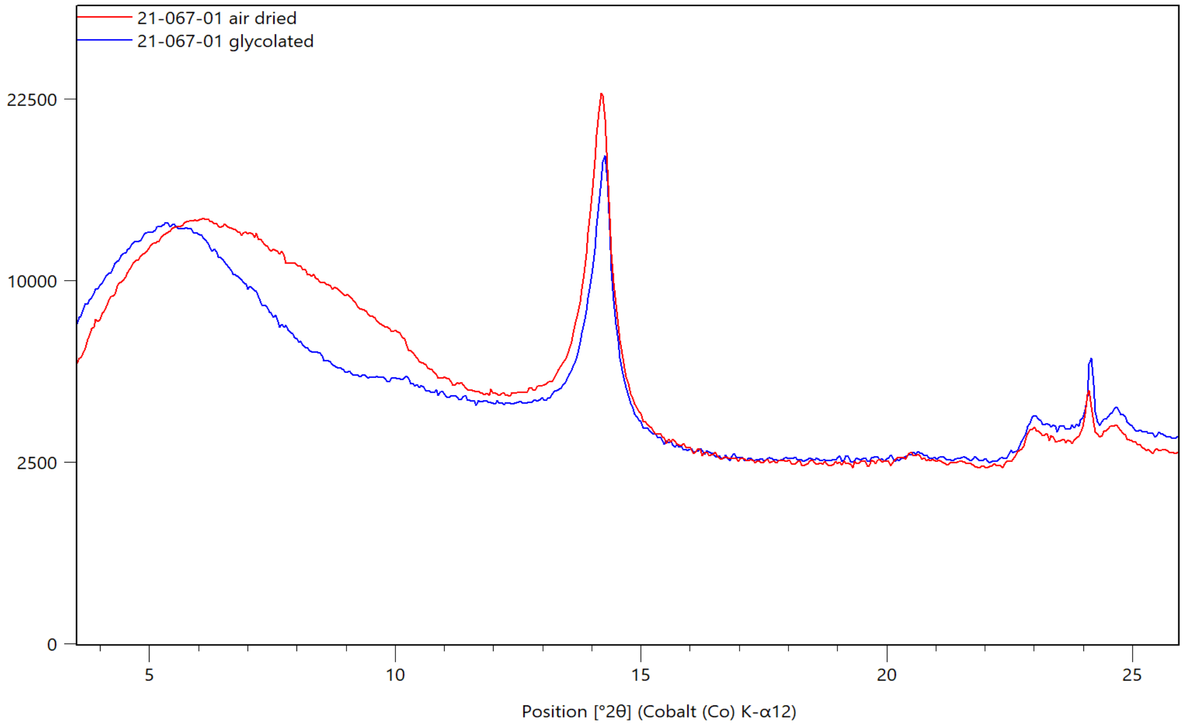


XRD trace obtained from #2020057-C2015 showing peaks indexed for the main phases identified.

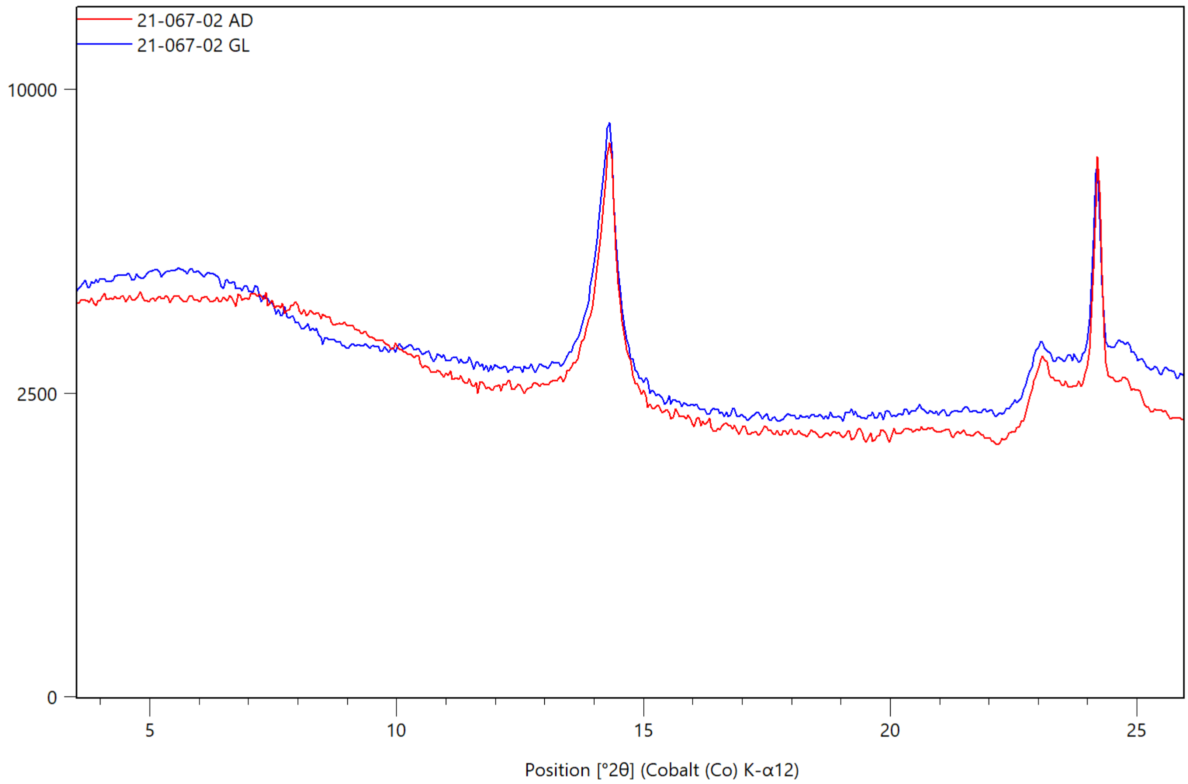


XRD trace obtained from #2020057-C2016 showing peaks indexed for the main phases identified.

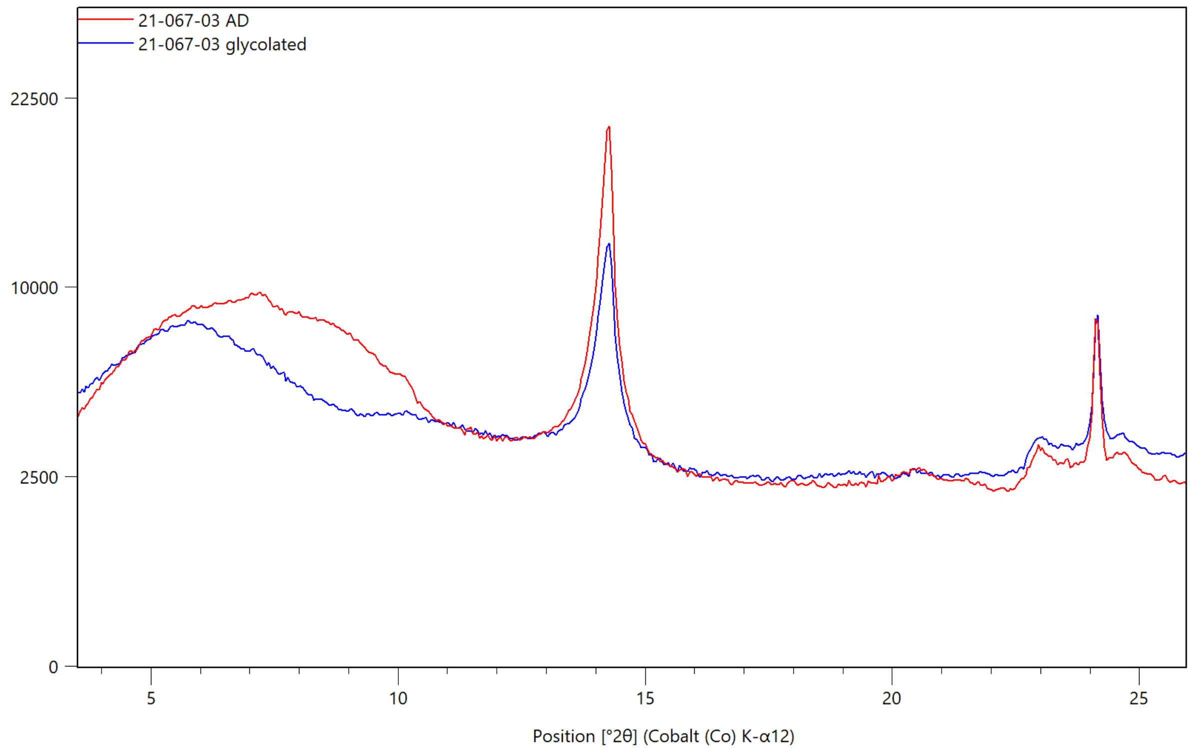
Sedimented Samples – note the clay fraction greatly concentrated and orientated.



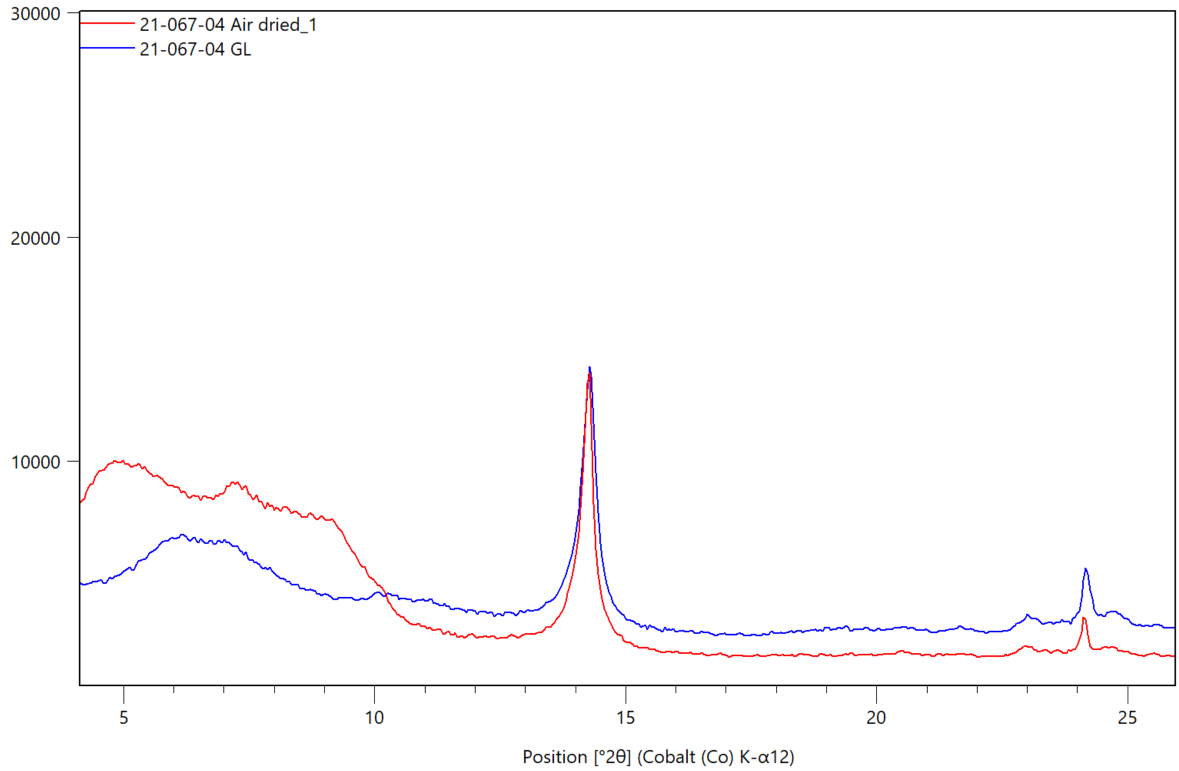
#2020057-C2013 demonstration of presence of smectite (montmorillonite) in the sample supplied – behaviour on glycolation



#2020057-C2014 demonstration of presence of smectite (montmorillonite) in the sample supplied – behaviour on glycolation



#2020057-C2015 demonstration of presence of smectite (montmorillonite) in the sample supplied – behaviour on glycolation



#2020057-C2016 demonstration of presence of smectite (montmorillonite) in the sample supplied – behaviour on glycolation

9.7 Attachment G: Soil Water Group SWCC report

SOIL WATER ANALYSIS

TEST REPORT

soilwater GROUP

45 Gladstone St
East Perth WA 6006
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Client: RGS Environmental
Client Contact: Alexandra Kiss; Greg Maddocks
SWA Job No.: JN0735
Date of Analysis: 15th March - 31th March 2021
No. Samples Submitted: 12

Method:
- Pressure plate method used in accordance with McKenzie, N., Coughlan, K. and Cresswell, H. (2002). Soil Physical Measurement and Interpretation for Land Evaluation, CSIRO Publishing.
- Samples packed to a bulk density of 1.50 g/cm^3 on the pressure plates.
- Samples equilibrated for a 2 week period.

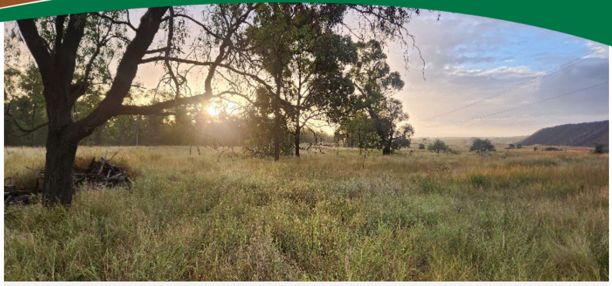
TEST RESULTS

SWA ID	Client ID	Volumetric Moisture Content (cm^3/cm^3)					Derived van Genuchten Parameters			
		0 kPa	10 kPa	33 kPa	100 kPa	1,500 kPa	α (1/cm)	N (-)	θs (cm^3/cm^3)	θr (cm^3/cm^3)
735-1	2020057-C2001	0.49	0.28	0.23	0.18	0.14	0.0967	1.328	0.486	0.103
735-2	2020057-C2002	0.43	0.29	0.22	0.18	0.13	0.0369	1.409	0.432	0.104
735-3	2020057-C2003	0.50	0.39	0.31	0.25	0.19	0.0187	1.482	0.496	0.171
735-4	2020057-C2004	0.50	0.30	0.19	0.15	0.11	0.0217	1.802	0.497	0.110
735-5	2020057-C2005	0.48	0.37	0.34	0.29	0.26	0.0371	1.369	0.477	0.232
735-6	2020057-C2006	0.46	0.37	0.25	0.23	0.17	0.0110	1.918	0.459	0.169
735-7	2020057-C2007	0.44	0.28	0.15	0.13	0.09	0.0150	2.083	0.443	0.091
735-8	2020057-C2008	0.41	0.26	0.14	0.12	0.09	0.0158	2.047	0.408	0.087
735-9	2020057-C2009	0.50	0.29	0.26	0.21	0.16	0.3366	1.199	0.500	0.085
735-10	2020057-C2010	0.50	0.31	0.28	0.24	0.19	0.8381	1.129	0.501	0.063
735-11	2020057-C2011	0.48	0.33	0.22	0.19	0.15	0.0197	1.741	0.483	0.144
735-12	2020057-C2012	0.42	0.32	0.27	0.23	0.18	0.0511	1.239	0.421	0.113

RGS

MINE WASTE AND
WATER MANAGEMENT

BROADMEADOW EAST ERODIBILITY TESTING AND EROSION MODELLING



Bowen Coking Coal Limited

September 2023

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Project Number: 2538.23a

Report Title: Broadmeadow East Erodibility Testing and Erosion Modelling

Client: Bowen Coking Coal Limited

Review History

Version Number	Prepared by:	Reviewed by:	Date
Rev 0 (draft)	I. Kelder	E. Howard	5/09/2023
Rev 1 (Final)	I. Kelder		20/09/2023

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1 INTRODUCTION

Bowen Coking Coal Limited (BCC) is developing a Progressive Rehabilitation and Closure Plan (PRPC) for the Broadmeadow East (BME) coal mine located 35km north of Moranbah. As part of this, BCC requires erodibility testing and erosion modelling of the proposed rehabilitation design for the East and West Out of Pit Dumps (OOPDs). Landloch Pty Ltd (Landloch) were engaged to conduct erodibility testing and erosion modelling of surface cover materials that will potentially be used to rehabilitate the OOPDs at BME.

A conceptual rehabilitation design of the OOPDs has been prepared by The Minserve Group Pty Ltd (Minserve). This design incorporates outer slopes with individual lifts that have 15% gradient and 20m vertical height, separated by a 5m wide berm between each lift. Inner slopes adopt a 12% gradient, 20m high batter height, separated by a 5m wide berm between each lift. It is understood that the rehabilitation surface will comprise a 0.3m thick layer of topsoil overlying overburden, with a target vegetation groundcover of 60%.

To assess the long-term erosional stability of the conceptual rehabilitation design, Landloch conducted a review of information to determine the available surface cover materials for use in rehabilitation. Samples of these materials were collected and underwent erodibility testing, with outcomes used to derive input parameters for erosion modelling. The erosion model was run to assess the erosion performance of a range of batter geometries and vegetation groundcover levels.

1.1 Scope of work

The following scope of work was undertaken:

1. Review available soils characterisation data with specific reference to the structural stability and erodibility of the soils available for rehabilitation.
2. Select suitable soils and undertake erodibility testing using laboratory-based techniques. Determine material-specific erodibility parameters for soils at the site using the erodibility testing results.
3. Conduct 2D runoff/erosion modelling to define:
    a. Erosionally stable waste rock landform batter geometries for the cover materials tested, and
    b. Vegetation cover levels required to achieve erosional stability.
4. Provide guidance on rehabilitation design.
5. Report the results (this report).

2 DESKTOP REVIEW

The intent of the desktop review is to understand the materials available for use in rehabilitation, the proposed rehabilitation strategy for the OOPDs, and the conceptual rehabilitation design of the OOPDs. This will assist in the selection of samples for erodibility testing and determine the vegetation groundcover level and typical batter heights and gradients to be considered in erosion modelling.

The following documents were provided for review:

- Bowen Coking Coal (2022) *Mineral Waste Management Plan, Broadmeadow East Project*, Coking Coal One Pty Ltd.
- Department of Environment and Science (2022) *Environmental Authority EA0002465.*
- Engeny (2021) *Bowing Coking Coal – Surface Water Impact Assessment*, Broadmeadow East Project, Report prepared for Bowen Coking Coal.
- Engeny (2023) *Bowen Coking Coal – Broadmeadow East Mine PRPC, Rehabilitation Flood Assessment*, Report prepared for Bowen Coking Coal.
- GeoTek Solutions (2021) *Geotechnical Assessments for Proposed Broadmeadow East Mine Project*, Report prepared for Bowen Coking Coal.
- Kolhn Crippen Berger (2021) *Groundwater Impact Assessment Report – Broadmeadow East Project*, Report prepared for Coking Coal One Pty Ltd.
- Nitro Solutions (2021) *Bowen Coking Coal – Broadmeadow East Baseline Ecology Assessment Report*, Report prepared for Bowing Coking Coal.
- RGS (2022) *Mine Material Assessment and Landform Stability Assessment*, Report prepared for Coking Coal One Pty Ltd.
- SGM (2021) *Soil and Land Resource Assessment, Broadmeadow East Project*, Report prepared for Nitro Solutions Pty Ltd on behalf of Coking Coal One Pty Ltd.

2.1 Rehabilitation strategy

The general rehabilitation and closure objectives for BME are to ensure that the post-mining condition of the landscape and final constructed landforms are (BCC 2022):

- Safe, stable and minimises long-term environmental impact;
- Without any future liability to the stakeholders; and
- In conformance with the agreed post-mining land use (PMLU).

Completion criteria and key rehabilitation indicators for the OOPDs are provided in the Environmental Authority (EA) for BME and are outlined in Table 1. The target PMLU for the OOPDs is low intensity grazing.

One key criteria of rehabilitation success is the restriction of erosion rates to <5t/ha/y and 10t/ha/y. Landloch interprets this as meaning the mean average annual erosion rates is to be <5t/ha/y and the mean peak annual erosion rate is to be <10t/ha/y. This provides useful target rates for the modelling of erosion. The target groundcover is 60% perennial pasture.

Table 1: PMLU and rehabilitation success criteria (adapted from DES 2022).

Goals	Objective/Indicators	Criteria	Validation method
Safe	Safety hazards in rehabilitation are similar to surrounding unmined landscapes.	Hazard assessment by a suitably qualified and experienced person	Risk is as low as reasonably practical (ALARP) in accordance with AS/NZS ISO 31000:2009 Risk Management
Stable	a. Landform development and reshaping/ reprofiling b. Surface preparation c. Structurally sound with no major slumping. d. No exposed hazardous material. e. No major erosion.	Outer slopes: • 15% as per landform design. • Vertical distance between berms: 20m. • Berm width: 5m • Drainage outward away from void towards original topo drainage paths. Inner slopes (into full backfill area): • 12% as per landform design. • Vertical distance between berms: 20m. • Berm width: 5m. • Drainage outward away from void towards original topo drainage paths. Subsidence • Subsidence monitored pre and post wet season and addressed accordingly. Factor of Safety • Geotechnical adequacy with 1.5 Factor of Safety.	• Certification from an AQP that the area has achieved stable condition. • All rehabilitated areas are geotechnically stable for the intended post mining grazing land use, with no active areas of rill or gully erosion, and; drainage follows appropriate drainage paths.

Goals	Objective/Indicators	Criteria	Validation method
Non-polluting	a. Surface Run off is minimized and is non-polluting to land and receiving waters. b. No environmental harm.	Receiving environment contaminant limit: • pH – 6.5-8.5 • EC – baseflow 0.72mS/m, high flow 0.25mS/m. • Turbidity – 50NTU • Aresnic - 13µg/L • Molybdenum – 0.15mg/L • Selenium - 5µg/L • Sulfate – 25mg/L • Suspended solids – 55mg/L • Groundwater aquifers maintain their pre-mining or reference bore water quality. • Erosion rate of <5t/ha/y and 10t/ha/y as determined by landform design. • The installation of certified contours and drains as per design by an AQP (CPESC). • 5m of capping rejects within OOPD with overburden that is non-reactive (geochemically and physically inert).	• Assessment of soil health and suitability has been completed by an AQP. • Receiving water quality indicators do not exceed specified criteria limits. • Groundwater monitoring demonstrates that the groundwater quality is within 95th percentile of results of baseline pre-mining bore monitoring results, or when baseline is not available, reference bores which have not been impacted by mining activities. • Certification by an AQP that rejects are buried under geochemically and physically inert overburden with a minimum cover thickness of 5m.
Self-sustaining	a. Adequate vegetation. b. Ameliorate spoil as required to a depth of a minimum of 200 mm to suitably stabilize the landform, and c. Promote vegetative establishment.	• Groundcover 60% perennial pasture biomass. • Less than 5% of declared weeds (excluding Parthenium weed – *Parthenium hysterophorus*) • Land Class suitability 4 for grazing. • Abundance of declared weeds is less than reference sites. • No active areas of rill or gully erosion and drainage follows the appropriate drainage paths. • Resilience to fire and drought. • Soil nutrient concentrations and nutrient cycling comparable to reference sites.	• Results, that rehabilitated areas meet the land suitability assessment that meets class 4 for cattle grazing as defined by the Guidelines for Agricultural Land Evaluation in Queensland (State Department of Queensland 2015). • Certification of less than 5% declared weeds and pests species identified in rehabilitated areas. • Post closure flora and fauna monitoring as per the monitoring plan.

A re-constructed landform profile is proposed by RGS (2022), comprised of five components:

1. Foundational material,
2. Basement material,
3. Regolith,
4. Subsoil, and
5. Topsoil.

Topsoil thicknesses of approximately 0.5m are proposed, with underlying subsoil placed to a thickness of 2.5m or greater. In addition to this, erosion modelling conducted by SGM (2021) is based on topsoil being applied to the outer surface of the landform, with vegetation groundcover used to reduce the risk of erosion. As such, it can be assumed that topsoil is the most likely surface present on the rehabilitated landform.

RGS (2022) discusses the benefit of using rock mulch (rocky waste mixed with soil) to assist with management of erosion. It is noted that the use of rock mulch will be dependent on the ability to source adequate volumes of suitable rocky waste over the life of the mine, and that physical sampling and analysis completed to date verifies that there is competent and durable rock within overburden units available. It is unclear if the volumes discussed are for use in rehabilitation of the OOPDs, or for other purposes. It is further noted by RGS (2022) that placement of rock (nominally 150–300mm mean rock size at approximately 10-20% surface coverage) and deep ripping through the topsoil and subsoil along the contour can be evaluated as a method to slow and intercept surface runoff and reduce overland flow. It is Landloch's understanding that use of rock as a surface armour has not been considered further, and the rehabilitation design does not account for the addition of rock to the topsoil.

Based on the available information, it is understood that the rehabilitation design for the OOPDs will adopt a surface cover comprised of topsoil (and potentially subsoil if/where required), with vegetation established on the surface.

2.2 Soils

A soils investigation for BME was undertaken by SGM (2021). Five (5) soil types were identified:

1. Chromosols – Soils that show strong texture contrast between A horizons (surface soil) and B horizons (subsoil). They are generally non-sodic (ESP >6.0%) and not strongly acid (pH_w >5.5) especially in the upper 0.2m depth of the subsoil. These soils have moderate agricultural potential with moderate fertility and water-holding capacity. They can be susceptible to soil acidification and structural decline.
2. Dermosols – Soils that are moderately deep and well-drained, and present in wetter areas. They do not have a strong texture contrast between horizons and have a more developed than weak subsoil structure. They can support a wide range of land uses including grazing of native pastures, forestry, and some cropping.

3. Kandosols – Soils that lack a strong texture contrast between the surface soil and subsoil, a massive or weakly structured subsoil, and are not calcareous. The subsoil is generally well developed and has a maximum clay content in some part of the subsoil which exceeds 15%. Generally, they have a low to moderate agricultural potential with moderately fertility and water-holding capacity.
4. Kurosols – Soils with a strong texture contrast between loamy surface soil and clayey subsoil. The major part of the upper 0.2m of the subsoil is strongly acid (pH_w <5.5). Kurosols have a low agricultural potential because of low water-holding capacity.
5. Vertosols – Soils that are clay-rich (clay content >35%) with shrink-swell properties that exhibit strong cracking when dry. They are often associated with surface microrelief, or gilgai. They have high agricultural potential with high fertility and water holding capacity but require significant amounts of rain before water is available to plants. Vertosols can be difficult to cultivate and gypsum and/or lime may be needed to improve their structure.

Of the five soils, those present over the disturbance area (and therefore available to be stripped and stockpiled) are dominated by Chromosols (36%) and Vertosols (32%). Kandosols and Dermosols make up an appreciable proportion (19% and 14%, respectively). Kurosols make up a minor component (<1%). As such, it can be assumed that Chromosols and Vertosols will make up a sizeable component of the soils used for rehabilitation, and Kandosols an appreciable proportion.

Chromosols have no major limitations for their use. However, Vertosols are highly sodic and saline at depth. Based on this, recommended stripping depths provided by SGM (2021) are 0.5m for Chromosols (0.3m thickness of topsoil, 0.2m thickness of subsoil), and 0.15m for Vertosols (topsoil only).

In addition to this, there are existing topsoil stockpiles present in areas that have already been disturbed. The soils stripped from these areas are mapped primarily as Chromosols (47%) and Vertosols (26%).

As such, one sample of the existing stockpiled topsoil (Vertosol/Chromosol), and one sample of Kandosol (undisturbed) were selected for erodibility testing.

2.3 Vegetation groundcover

The target vegetation groundcover level is 60% and is to be comprised of perennial pasture species. No detailed information is available on vegetation groundcover levels in undisturbed areas, and if a 60% groundcover level can be achieved for rehabilitation. A review of the types of ecological communities was conducted by Nitro Solutions (2021). This review focused on the potential environmental values present across BME. However, no measures of vegetation groundcover were made. Images of the vegetation are provided in Figure 1 and show a generally sparse vegetation cover. Direct contact of vegetation with the ground surface (groundcover) is low in both images.

In addition to this, RGS (2022) recommended that a cover crop be adopted to stimulate the accumulation of carbon, organic matter, and nutrients in topsoil and subsoil horizons. RGS recommend that a carefully managed grazing land use is likely to have significant benefits for the long-term stability of the constructed landform.

As part of the soil survey completed by SGM (2021), images of typical vegetation present on the undisturbed soils were taken. These provide an indication as to potential cover levels that are present in the surrounding environment (Figure 1). This indicates that a reasonable level of vegetation cover (>60%) can potentially be achieved.

Discussions with BCC personnel indicate they hope to achieve a vegetation groundcover of 60%, in line with the requirements of the EA. As such, a target groundcover of 60% was used as the basis for erosion modelling for this project.

Figure 1: Examples of vegetation within the vicinity of BME (SGM 2021). Top image is on a Brown Chromosol, and bottom image on a Red Dermosol.

2.4 Conceptual landform rehabilitation design

The conceptual landform rehabilitation design for the OOPDs is shown in Figure 2 and Figure 3, with cross-sections provided in Figure 4. Drainage lines are provided in Figure 5. The design is comprised of four distinct sections:

1. Eastern landform;
2. Western landform;
3. Central flat; and
4. Southern pit.

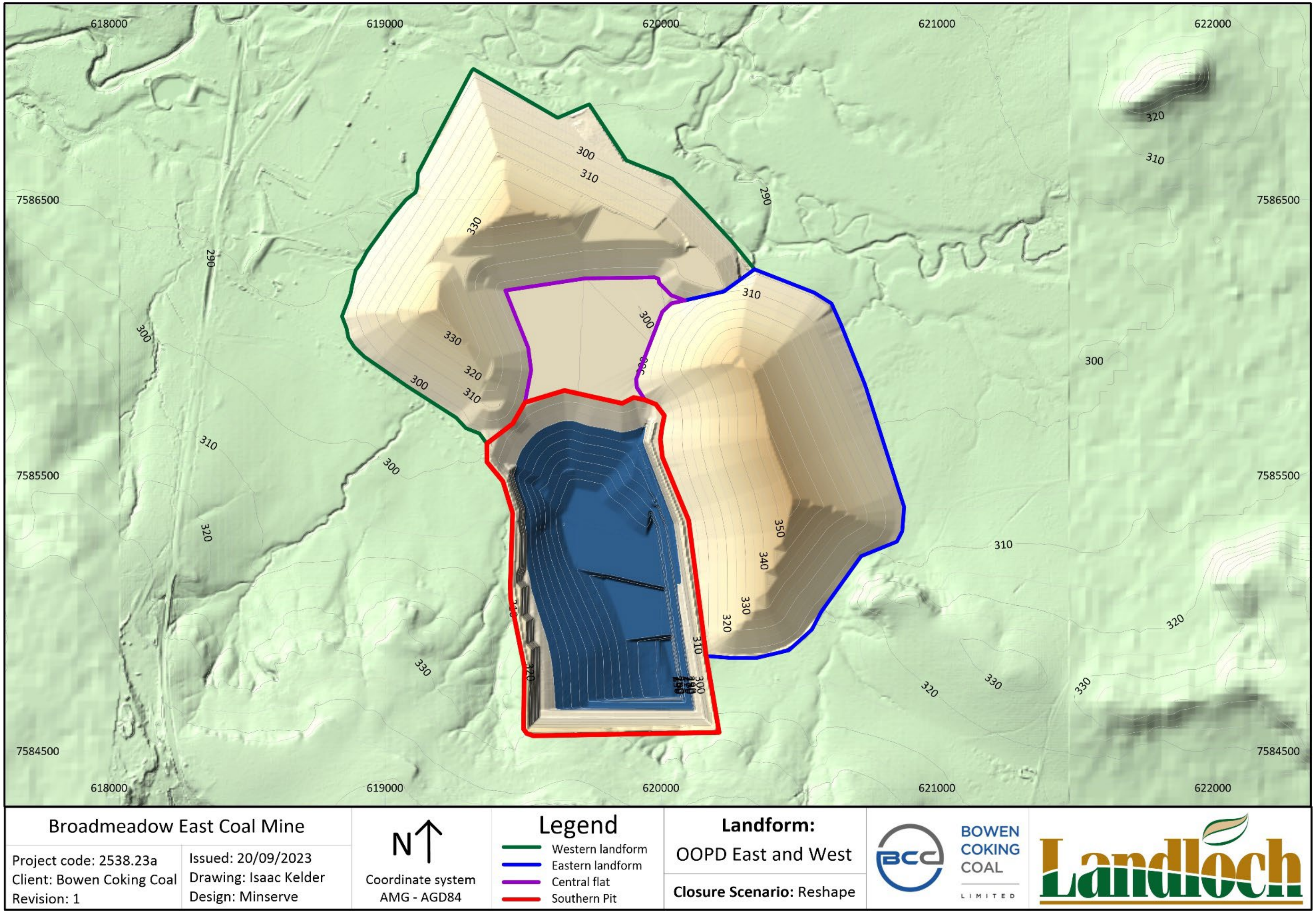

Figure 2: Areas of the proposed OOPD East and West rehabilitation design.

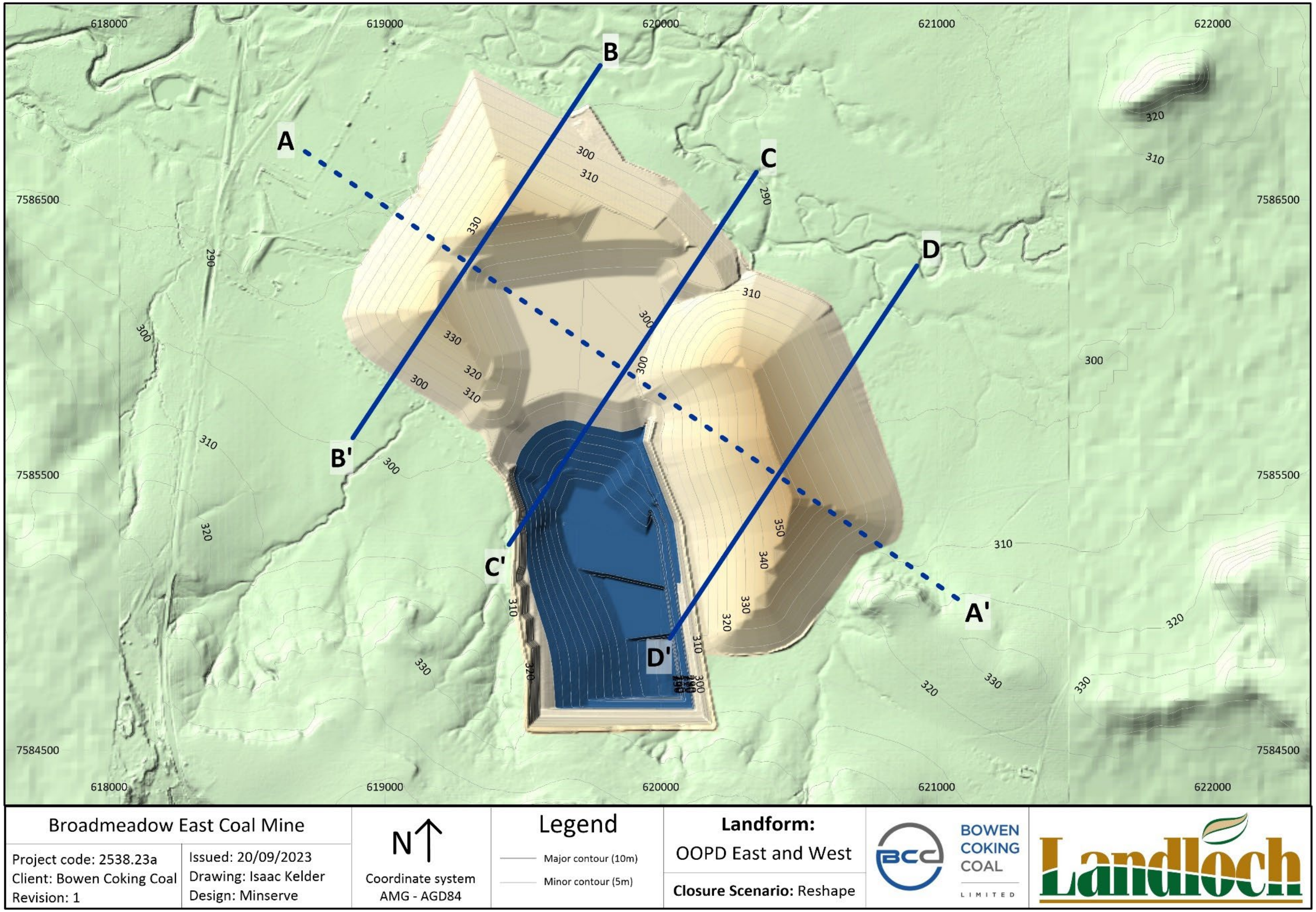

Figure 3: Proposed Rehabilitation design for OOPD East and West.

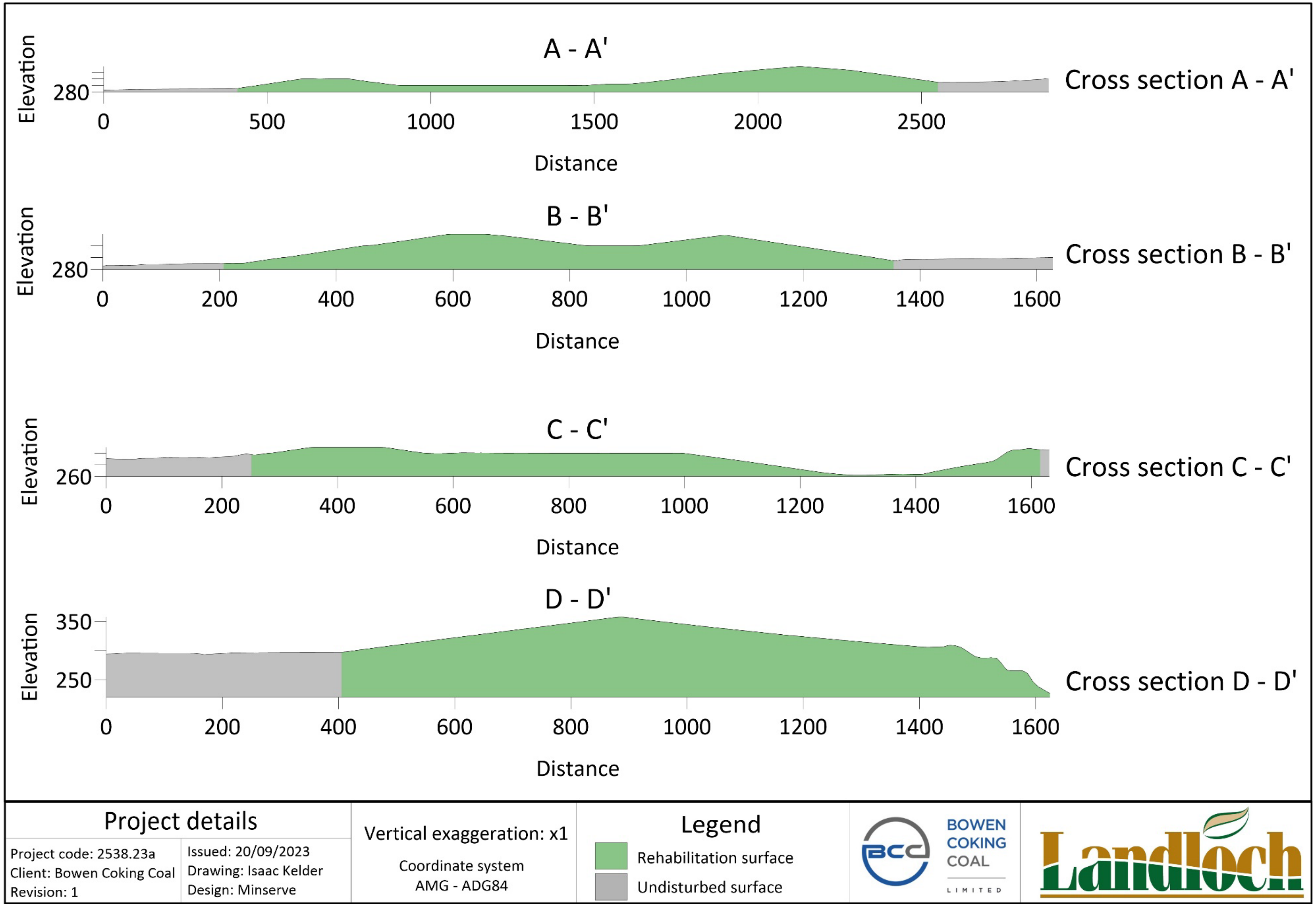

Figure 4: Cross sections of proposed rehabilitation design for OOPD East and West.

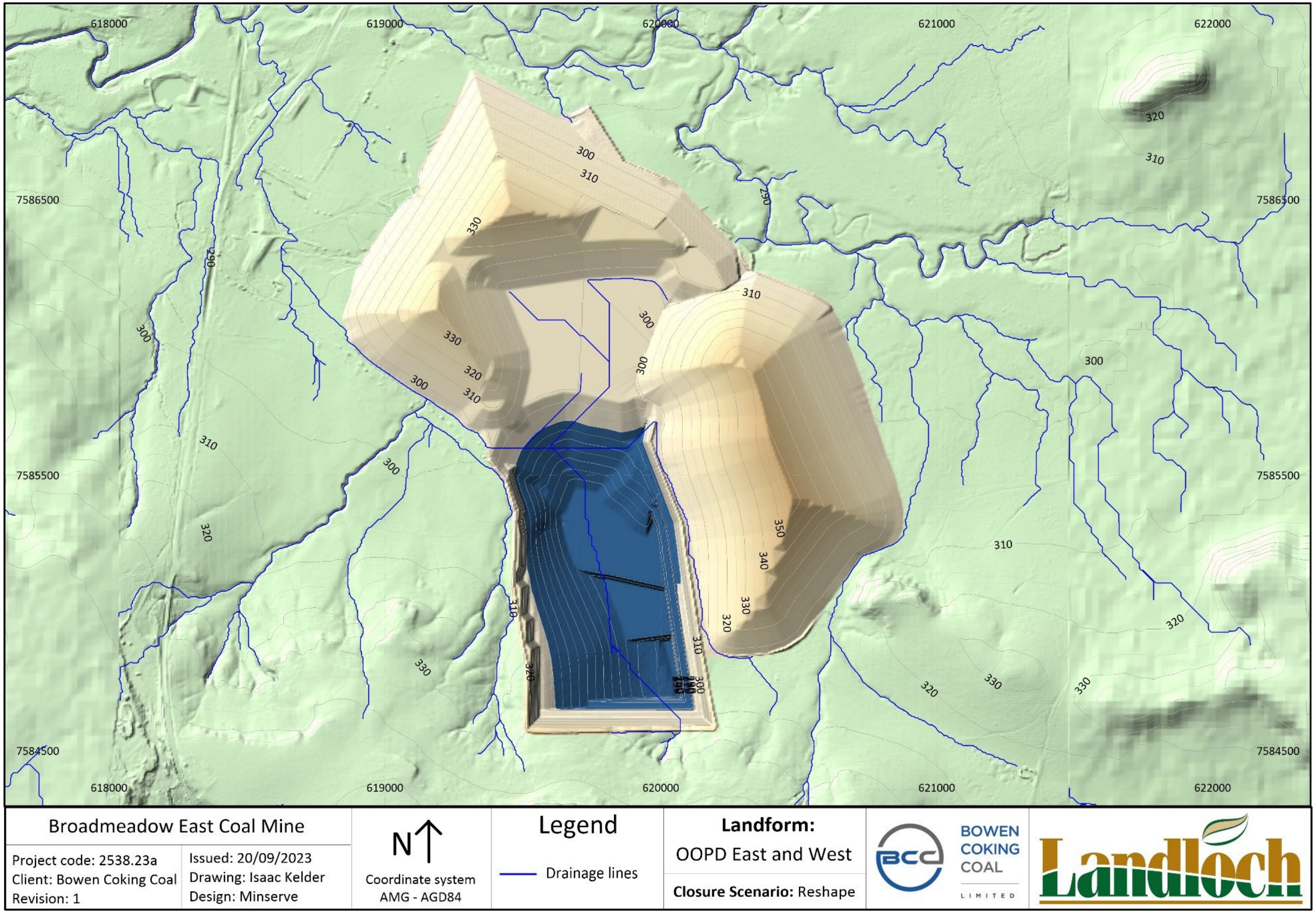

Figure 5: Drainage lines of the proposed rehabilitation design.

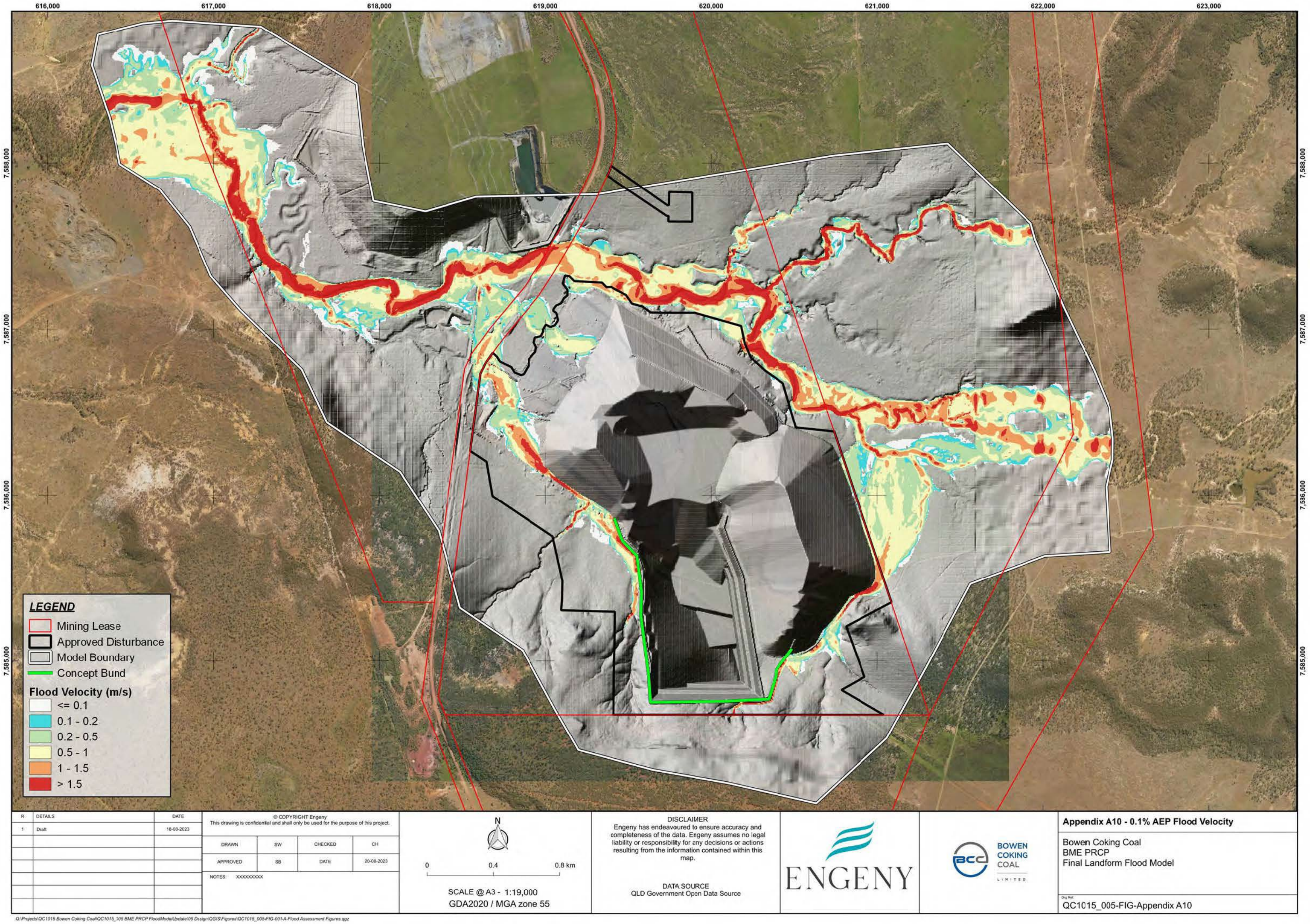

Figure 6: Surface water modelling showing velocities (m/s) for a 0.1% AEP for proposed rehabilitation design (Engeny 2023)

2.4.1 Landform characteristics

2.4.1.1 Eastern landform

The eastern landform is comprised of variable batter heights ranging from 15–50m, with most of the landform at a height of 50m above the surrounding ground level. A linear outer batter gradient of 15% has been adopted for the entire landform.

The northern and north-eastern sides of the landform include 5m wide berms at a 20m batter height interval. These berms are not intended to be permanent features of the landform, but rather are intended to assist with the initial establishment of vegetation and to reduce erosion in the short term. The eastern landform tops are typically ridges, with 15% gradient batter slopes on both sides. There are several small flat tops which have zero gradient, with no crest bunding present on these tops.

2.4.1.2 Western landform

The western landform has batter heights that range from 50–60m, with linear batter gradients of 15%. The top of the landform is characterised by a ridge that runs from north to south, splitting into two at the southern end.

2.4.1.3 Central flat

The central flat is a large section in the middle of the landform with zero gradient. This area receives surface water runoff from sections of the eastern and western landform. The southern end of this section abuts the pit.

2.4.1.4 Southern pit

The southern pit section is comprised of variable batter heights and gradients. The northern end of the pit has a 50m batter height, and a 15% linear batter gradient. The western end is comprised of a variable batter height, ranging from 50–100m, increasing in height further to the south. The batter is comprised of two sections. The top section is 20m in height and is at angle of repose (~60°), and the bottom section varies from 30–70m with a linear batter gradient of 15%.

The southern and eastern sections of the pit are comprised of a typical pit face, with three lifts at a height of 20-30m, with benches 20m wide separating each lift.

2.4.2 Landform position

The conceptual rehabilitation design is located lower in the landscape, with hills located directly south, east, and west of the landform. A drainage analysis (Figure 5) indicates that drainage across the undisturbed area flows in a north-westerly direction. There are several drainage lines that intersect with the conceptual design, including the southern section of the eastern landform, and the eastern section of the western landform.

Flood modelling conducted by Engeny (2023) indicates that for a 0.1% AEP event (1:1000 year rainfall event) velocities above 1.5m/s are likely to impact on the western edge and south-eastern edge of the landform (Figure 6). These sections will likely require rock armouring to protect from scour erosion. This may pose a risk for long-term erosional stability if the velocity of these flows exceed the capacity of the sheeting materials to withstand detachment. It is noted that assessment of this risk falls outside the scope of this project.

2.5 Summary

Based on the desktop review, the following is concluded:

- The proposed rehabilitation strategy is to reconstruct the soil profile through placement of topsoil, and potentially subsoil if/where required.
- The post mining land use will be low intensity grazing.
- EA requirements state erosion should remain below 5t/ha/y and 10t/ha/y. Landloch interprets this as meaning the mean average annual erosion rates is to be <5t/ha/y and the mean peak annual erosion rate is to be <10t/ha/y.
- Rock armour is not proposed to be used.
- Topsoils are likely to be comprised of Chromosols and Vertosols, as well as an appreciable component of Kandosols.
- Target vegetation groundcover level is 60%.
- Achievable vegetation groundcover levels are not yet known.
- The conceptual landform will be comprised of batter heights between 20–50m, and linear batter gradients of 15%.
- Scouring may occur during large rainfall events which may require armouring of the toe of the landform to the west and southeast.

3 ERODIBILITY TESTING AND MODEL SETUP

One bulk sample of Chromosol/Vertosol and one bulk sample of Kandosol were collected by BCC on 4 April 2023. The sampling locations are illustrated in Figure 7, and images of the sampling conducted are provided in Figure 8. Sub-samples of the two bulk samples were assessed for basic material characteristics:

- Soil pH_w in a 1:5 solid:water solution;
- Electrical Conductivity ($EC_{1:5}$) in a 1:5 solid:water solution;
- Exchangeable cations (Ca^{2+}, Mg^{2+}, Na^+, K^+, Al^{3+});
- Effective Cation Exchange Capacity (ECEC) calculated as the sum of exchangeable cations;
- Exchangeable Sodium Percentage (ESP) calculated as the ratio of exchangeable sodium to ECEC expressed as a percentage;
- Exchangeable Magnesium Percentage (EMP) calculated as the ratio of exchangeable magnesium to ECEC expressed as a percentage;
- Ca:Mg calculated as the ratio of exchangeable calcium (meq/100g) to exchangeable magnesium (meq/100g);
- Electrochemical Stability Index (ESI) calculated as the ratio of $EC_{1:5}$ (dS/m) and ESP (%); and
- Particle size distribution (PSD) (coarse sand, fine sand, silt, clay).

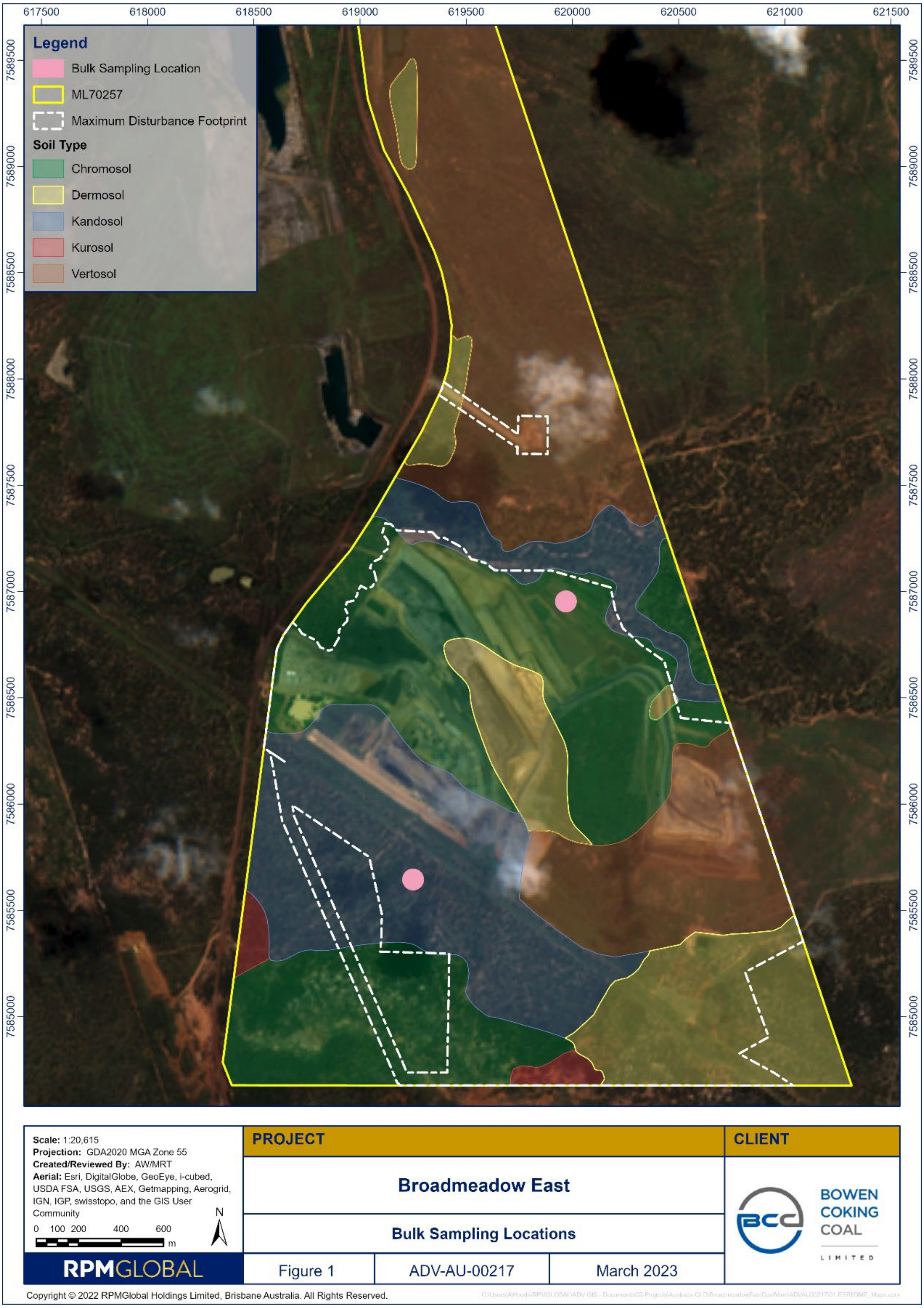

Figure 7: Sample locations for the Chromosol/Vertosol and the Kandosol.

Figure 8: Sampling of the Chromosol/Vertosol (top image) and the Kandosol (middle and bottom image).

3.1 The WEPP model

The WEPP (Water Erosion Prediction Project) model was developed by the United States Department of Agriculture to predict runoff, erosion, and deposition for hillslopes, akin to mine landform batter slopes (Flanagan and Nearing 1995). WEPP is a simulation model with a daily input time step, although shorter time steps are used by internal calculations for the prediction of runoff and erosion on days when rain occurs.

On days without rain, the WEPP model uses the climate data to modify plant and soil characteristics. Of importance for this project, soil evaporation occurs of days without rain and profiles are therefore dried between rain events. This has a bearing on runoff and erosion predictions. On days with rain, the plant and soil characteristics are used as initial conditions in predicting the occurrence of runoff and erosion. If runoff is predicted to occur, the model computes sediment detachment, transport, and deposition at points along the slope.

The erosion component of WEPP uses a steady-state sediment continuity equation as the basis for erosion computations. Soil erosion in interrill areas is calculated as a function of the effective rainfall intensity and runoff rate. Soil erosion in rills is predicted to occur if the flow hydraulic shear stress is greater than the material's critical shear stress, and when the sediment concentration in the runoff is less than its transport capacity. Deposition in rills is computed when the sediment concentration in the runoff is greater than the capacity of the runoff to transport it. There are four components within the WEPP model that are relevant to this project:

1. Material erodibility;
2. Slope geometry;
3. Climate; and
4. Vegetation.

3.2 Material erodibility

Laboratory based erodibility testing was conducted on the stockpiled Vertosol/Chromosol and undisturbed Kandosol. This erodibility testing enabled the parameterisation of the WEPP runoff/erosion model. Key material input parameters for WEPP include:

- Interrill erodibility;
- Rill erodibility;
- Critical shear for rill initiation;
- Effective hydraulic conductivity; and
- Sediment particle size and density distributions.

Interrill erodibility (K_i) describes the detachment and movement of particles by the combined action of raindrops and shallow overland flows. Rill erodibility (K_R) describes the detachment of particles by shear stresses caused by concentrated flows. Critical shear for rill initiation (τ_c) is the shear stress applied by concentrated flows to the surface above which particle detachment and transport by flow rapidly increases and rills form. Effective hydraulic conductivity (K_e) defines the rate of water movement through a defined soil profile in response to wetting by rainfall and is derived through analysis of a material's steady infiltration and runoff rates. The calibrated WEPP erodibility parameters for these parameters were derived from experimental methods involving the application of:

- Simulated rain and measurement of runoff rate and sediment loads in runoff to obtain estimates of K_i and K_e; and
- Concentrated surface water flows and measurement of flow characteristics and sediment loads to obtain estimates of K_R and τ_c.

Prediction of erosion rates are sensitive to the particle size and density distributions of the eroded sediment. The version of the WEPP model available for general use has been coded to estimate sediment properties based on fixed sediment particle size and density distributions. However, Landloch has a specialised version of WEPP that allows input of material-specific sediment particle size and density distributions. This version of WEPP has been used because it can more accurately predict erosion.

Samples of the rain-impacted surface from all materials were taken using the methods described by Loch (1994). These samples were placed into automated settling columns that provide equivalent sand size distributions for the generated sediment (Loch 2001). Equivalent sand size distributions integrate both particle size and density distributions into a single distribution that is representative of the sediment and that can be readily input to WEPP.

3.3 Slope geometry

The slope geometry for which erosion is predicted is defined by the WEPP model user. Valid geometries can include slopes with uniform/linear gradients as well and more complex geometries such as concave and convex profiles. Slope geometries used for this project are uniform/linear, in line with the proposed rehabilitation design of the OOPDs. The range of modelled geometries included various batter heights (10–60m) and gradient (10% and 15%) to assess the impact of shape on erosion.

3.4 Climate file

Apart from information on the slope profile geometry and the surface materials, modelling of long-term erosion with WEPP requires a long-term climate sequence for the site. For each day of simulation, WEPP requires 10 daily climate variables:

- Rainfall,
- Rainfall duration,
- Peak rainfall intensity,
- Time to rainfall peak,
- Solar radiation,
- Minimum temperature,
- Maximum temperature,
- Dew point temperature,
- Wind speed, and
- Wind direction.

Of these, the 4 rainfall-related variables (underlined above) are critical because predicted runoff and erosion are most sensitive to these variables (Nearing *et al.* 1990; Chaves and Nearing 1991).

Complete historical datasets on these 10 climate variables are not available for most sites. Completion of WEPP for runoff/erosion predictions requires synthetic climate sequences that statistically preserve the mean and variations in climate datasets sourced from nearby climate observation stations.

CLIGEN is a stochastic weather generator that can be used to provide the necessary WEPP climate input files. CLIGEN has been assessed for a wide range of climates, and it was found that it was suitable for providing the required climate input for WEPP to predict runoff and erosion (Yu 2003).

Daily rainfall data for BME were sourced from the Australian Bureau of Meteorology (BoM) for the through the SILO patched point data facility. Patched point data provides a continuous daily data set of observed data that has data gaps filled with synthetic data that is based on observed data from nearby BoM stations. Patched point data was sourced from Moranbah Water Treatment Plant (-21.99°S, 148.03°E), approximately 22km from the location of BME. Climate statistics created for this station include[1]:

- Mean daily rainfall on wet days for each month,
- Standard deviation and skewness coefficient of daily rainfall for each month,
- Probability of a wet day following a dry day for each month,
- Probability of a wet day following a wet day for each month,
- Mean daily max. temperature for each month,
- Standard deviation of daily max. temperature for each month,
- Mean daily min. temperature for each month, and
- Standard deviation of daily min. temperature for each month.

Pluviograph (6-minute) rainfall were available for BoM's site at the Moranbah Water Treatment Plant (site number 34038), located ~22km from the site. At the time the file was created, pluviograph data records exist for this site from January 1986 to June 2006. Similar to the daily climate statistics, sub-daily rainfall statistics were created for this site. They included:

- Mean maximum 30-min rainfall intensity for each month, and
- Probability distribution of the dimensionless time to peak storm intensity.

A 100-year climate sequence was generated from these daily and sub-daily statistics using CLIGEN version 5.1 (Yu 2002). The resultant climate sequence has sub-daily rainfall properties and daily, monthly, and annual climate statistics that are consistent with Moranbah.

[1] The Priestley-Taylor method for estimating potential soil evaporation is automatically used by WEPP, and as such wind data are not required.

3.5 Vegetation impacts

Impacts of vegetation cover on infiltration rates were estimated using the relationship between vegetative groundcover reported by Kato *et al.* (2009). Direct impacts of groundcover on erosion rates were estimated using cover (C) factors for the Revised Universal Soil Loss Equation (RUSLE) (Renard *et al.* 1993) listed in Rosewell (1993).

A range of vegetation cover levels were assessed to determine what cover levels would be required to achieve erosional stability for a given batter geometry.

Two points should be noted:

a) In considering "vegetation cover" or "surface cover", this report specifically considers contact cover of vegetation on the soil surface. Practically, this means a combination of grass cover and anchored (not readily moved) surface litter. This is referred to as groundcover.
b) Considerations of surface cover do not include rock. Where rocky materials have had erodibility measured experimentally and those parameters are used in WEPP simulations, the effects of the rock on erosion are already accounted for within the parameters used.

Vegetation groundcover levels assessed include 0%, 30%, 40%, 50%, 60%, 70%, and 80%.

3.6 Other model assumptions

The modelling assumes that no runoff from upslope areas is permitted onto the batter profile being modelled. This is consistent with the condition where a bund or backsloping berm is present at the crest of the batter that blocks the flow of runoff from upslope areas onto the batter.

If runoff from upslope areas is permitted to discharge to the batter being modelled, the erosion predictions will be much higher than stated and the batter profile will not be erosionally stable.

3.7 Definition of 'acceptable erosion'

Some degree of erosion will always occur from any land surface. The concept of 'acceptable' erosion is widely mentioned, but common definitions appear to have little relevance to mine site rehabilitation. For example, Wischmeier and Smith (1978) defined tolerable soil loss for cropland as "*the maximum rate of soil erosion that will permit a high level of crop productivity to be sustained economically and indefinitely.*"

A value of 4.5t/ha/y was developed for erosion of rangeland soils and shallow cultivated soils by USA soil conservation agencies (Wight and Siddoway 1979) using similar criteria to those applied for crop land (i.e. maintenance of land productivity). In contrast to only considering land productivity, Landloch's approach to landform design aims to create rehabilitated slopes on which rilling will be minimised. In the mining context, rilling:

- Is most likely to lead to further flow concentration and possibly drive the formation of gullies that in turn will greatly accelerate erosion rate over time;
- Generates significantly more sediment by weight than interrill erosion;
- Is more likely to increase the risk that the integrity of a dump sheeting layer is compromised, possibly exposing more problematic wastes below the sheeting layer;
- Increases the removal of materials from the land surface which in turn negatively impacts on vegetation establishment and growth in areas affected by rills; and
- Is a more visible form of erosion than interrill erosion, and is often the focus of erosion assessments by regulators.

In Landloch's experience, long-term annual erosion rates that produce batters with a low tendency to rill are:

- Mean average annual erosion – 5t/ha/y; and
- Mean peak annual erosion – 10t/ha/y.

The rates that Landloch adopt for landform design are in line with the conditions of the EA for BME.

4 TESTING RESULTS

Results of the sub-sample analysis of the bulk samples are provided in Table 2. Images of the flume and rainfall simulations can be found in Appendix A.

Table 2: Sub-sample analysis of the Vertosol/Chromosol and Kandosol bulk samples.

Analysis	Unit	Vertosol/Chromosol	Kandosol
pH, EC			
pH_w	-	6.7	7.9
$EC_{1:5}$	dS/m	0.19	0.03
Exchangeable Cations			
Ca	meq/100g	5.4	2.1
Mg	meq/100g	3.4	0.4
K	meq/100g	0.4	0.3
Na	meq/100g	1.1	<0.1
Al	meq/100g	<0.1	<0.1
ECEC	meq/100g	10.3	2.9
Particle Size Distribution*			
Coarse Fraction	%	6	4
Fine Fraction	%	94	96
Coarse Sand^	%	47	33
Fine Sand^	%	24	26
Silt^	%	8	7
Clay^	%	15	30
Stability Indices			
ESI	-	0.02	0.02
FS+S+C	%	47	63
Ca:Mg	-	1.6	4.9
ESP	%	11	1.5
EMP	%	33	15

* Sand, Silt, and Clay are expressed as a percentage of the fine fraction only. ^Coarse sand: 2.0-0.2mm; fine sand: 0.2-0.02mm; silt: 0.02-0.002mm; clay: <0.002mm.

4.1 Soil pH_w

Soil pH for the Vertosol/Chromosol is circum-neutral, and for the Kandosol slightly alkaline. These values are in line with those recorded by SGM (2021) and are unlikely to be restrictive to plant growth.

4.2 Salinity ($EC_{1:5}$)

Both the Vertosol/Chromosol and the Kandosol have low salinity, with values of 0.19dS/m and 0.03dS/m, respectively. Salinity is not considered to be a limiting factor for plant growth.

4.3 Structural stability

Structure is the arrangement of primary particles into secondary units or peds. The secondary units are characterised on the basis of size, shape, and grade. A structurally unstable soil or waste is one that tends to have minor or reducing particle arrangement. It is important to note that structural stability as used in this report is different to geotechnical stability. Structurally unstable soils or wastes may be prone to:

- tunnel erosion;
- increased bulk density and hardsetting surfaces;
- increased runoff and erosion potential;
- reduced water holding capacity and infiltration capacity; and
- reduced root penetrability.

A soil or waste's potential to have an unstable structure is dependent on both its chemical and its physical characteristics. These are considered in a number of ways.

The proportion of exchangeable Na held on the soil or waste's exchange complex in relation to other exchangeable cations is important. This is referred to as the Exchangeable Sodium Percentage (ESP). McKenzie *et al.* (2004) considers the measurement of ESP as suitable for assessing the potential for clay dispersion when a material's ECEC is >3meq/100g and exchangeable Na >0.3meq/100g. Further, clay dispersion risk is greatest in materials with loam or clay textures (clay fraction >10%). Sand dominated wastes are not prone to structural instability due to high ESP.

Clay dispersion potential for a soil or waste is also influenced by interactions between clay content, ESP, and $EC_{1:5}$. The Electrochemical Stability Index (ESI) is a means of considering the relationship between ESP and $EC_{1:5}$ for loam and clay textured soils (clay fraction >10%). A tentative critical ESI value is 0.05 (NSW Agriculture 1998), with ESI <0.05 and clay content >10% indicating a material that is prone to structural instability due to clay dispersion.

Magnesic soils and wastes can also be prone to clay dispersion. This is assessed using a combination of the Exchangeable Magnesium Percentage (EMP), Ca:Mg ratio, ESP, and clay content. Where the EMP >30%, clay dispersion may occur when Ca:Mg ratio is <1, and ESP is >4% or (ESP + EMP/10) is >6%, assuming they also have >10% clay (Fenton and Conyers 2002).

Materials with a high combined proportion of fine sand, silt, and clay (particles ≤0.2mm) are prone to structural instability, even if their clay fractions are not chemically dispersive. This is because these smaller particles can mobilise within the coarser sand matrix. For this reason, materials with a combined fine sand, silt, and clay fraction >70% are considered to be at increased risk of structural instability (Vacher *et al.* 2004).

It is noted that a soil or waste can have a fine fraction that is prone to structural instability, but if the proportion of unstable fines is small, the material as a whole may be structurally stable. Typically, a binary mixture with >30-40% fine materials and <60-70% coarse materials could be considered a fine material with some coarse fraction; a binary mixture with <30-40% fines and >60-70% coarse materials could be considered a coarse material with some fine fraction. Based on this, a fines cut-off of >40% seems reasonable, with materials that contain >40% fines being at risk of structural instability if the fine fraction meets one or more of other criteria (ESP, ESI, exchangeable Mg, or PSD). Materials with <40% fines are classified as not being prone to instability, even in the fine fraction is prone to instability.

To capture interactions between physical and chemical properties and their effect on structural stability, the soil samples were assessed against four sets of conditions (Table 3). If any of these condition sets are met, the material was classified as being prone to structural instability.

Table 3: Condition sets used to define structural instability.

ESP Condition	EMP Condition
• Clay content >10% of fines, and • Fines >40% of whole, and • ECEC >3meq/100g, and • Ex. Na >0.3meq/100g, and • ESP >6%.	• Clay content >10% of fines, and • Fines >40% of whole, and • EMP >30% & Ca:Mg <1 & ESP >4%, or • EMP >30% & Ca:Mg <1 & (ESP + (EMP/10) >6%.
ESI Condition	**PSD Condition**
• Clay content >10% of fines, and • Fines >40% of whole, and • ESI <0.05.	• Fines >40% of whole, and • Fine sand + silt + clay >70% of fines.

In general, the Vertosol/Chromosols are sodic, and due to low salinity have an ESI value that is low (<0.05), and as such are considered to be prone to structural instability. The sodicity of the soils will lead to dispersion of the clay fraction, leading to reduced infiltration capacity, hardsetting, and also the potential to be prone to tunnel erosion. The low ESI value may also lead to structural instability, especially given the low abundance of coarse fragments. As a result of these risks, the Vertosol/Chromosol may be more prone to erosion.

The Kandosols are non-sodic, but similar to the Vertosol/Chromosol, have low salinity resulting in a low ESI value. Given the low coarse fraction of the Kandosol, it could be expected that this soil will have a reduced infiltration capacity and higher density values, and also be more prone to tunnel erosion. As such, the Kandosols may be more prone to erosion.

4.4 WEPP model parameters

WEPP erodibility parameters were derived for both the Vertosol/Chromosol and the Kandosol (Table 4). The Vertosol/Chromosol exhibits very low effective hydraulic conductivity, whereas the Kandosol has a moderate effective hydraulic conductivity. The K_i for both soils is similar. Rill erodibility is higher in the Kandosol compared to the Vertosol/Chromosol. However, the Vertosol/Chromosol has a higher critical shear than the Kandosol.

Table 4: WEPP parameters derived for the two soils.

Material	Effective hydraulic conductivity, K_e	Interrill erodibility, K_i	Rill erodibility, K_R	Critical shear, τ_c
	mm/h	kg.s/m⁴	s/m	Pa
Vertosol/Chromosol	1	1,569,782	0.0032	15
Kandosol	14	1,495,696	0.0164	7

The equivalent sand sediment size distributions input to the WEPP models for both of the materials is shown in Figure 9. Broadly, particles with an equivalent sand particle size <0.1mm are difficult to settle in slow moving, low turbulence runoff. These finer sediments are likely to be mobile and readily transported in runoff. Sediments that have larger equivalent sand particle sizes tend to settle and deposit close to the toe of the landform or within runoff control structures such as toe drains. For the Vertosol/Chromosol, ~50% of the sediment produced will be easily mobilised, and for the Kandosol 35% will be easily mobilised.

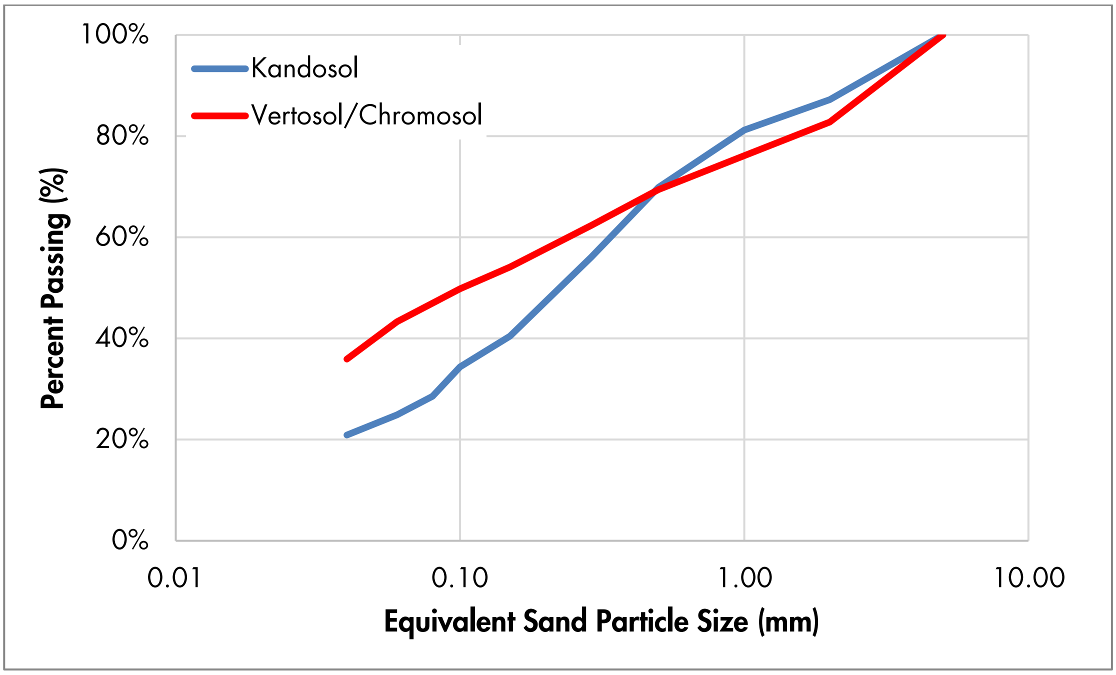

Figure 9: Sediment size distribution for the Kandosol and Vertosol/Chromosol.

5 WEPP MODELLING RESULTS

5.1 Impact of vegetation and batter height

Modelling of long-term erosion for the OOPDs considered combinations of surface materials, batter geometries, and vegetation groundcover levels. The following combinations were initially assessed:

- Batter gradient of 15%, consistent with those present on the proposed rehabilitation landform;
- Batter heights varying between 10–60m (at 10m intervals), consistent with those present on the proposed rehabilitation landform; and
- Vegetation groundcover levels varying from bare (0%), and 30–80% (at 10% intervals).

WEPP modelling results are presented in Table 5. Orange cells indicate batter geometries and vegetation groundcover levels with erosion that exceed acceptable threshold values, with green cells indicating those within acceptable threshold values.

Table 5: Average annual erosion (mean and peak) for the Vertosol/Chromosol and Kandosol with a batter gradient of 15%, varying batter heights and varying vegetation cover percentages.

Soil	Height (m)	Gradient (%)	Average Annual Erosion (t/ha/y) for percentage vegetation cover (%)													
			0%		30%		40%		50%		60%		70%		80%	
			Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak
Vertosol / Chromosol	10	15	233	599	12	43	6	22	3	12	2	6	1	3	<1	1
	20	15	495	1,080	35	94	18	47	9	24	4	12	2	6	<1	1
	30	15	695	1,360	53	123	26	61	13	30	7	15	3	8	1	1
	40	15	841	1,530	65	137	32	67	16	33	8	16	4	8	1	2
	50	15	949	1,620	74	144	36	70	19	34	9	17	4	8	1	2
	60	15	1,031	1,670	80	146	39	70	19	35	9	17	5	8	1	2
Kandosol	10	15	353	485	37	56	18	28	10	14	5	7	3	4	<1	1
	20	15	393	465	42	54	21	27	11	14	5	7	3	3	1	1
	30	15	391	441	42	51	20	25	10	13	5	6	3	3	1	1
	40	15	380	423	40	47	20	23	10	12	5	6	3	3	1	1
	50	15	366	403	38	45	19	22	9	11	5	6	2	3	1	1
	60	15	354	385	37	42	18	20	15	21	4	5	2	3	1	1

*Orange cells indicate erosion above acceptable threshold values (>5t/ha/y mean, >10t/ha/y peak). Green cells indicate erosion within acceptable threshold values (<5t/ha/y mean, <10t/ha/y peak).

Table 6: Average annual erosion (mean and peak) for the Vertosol/Chromosol and Kandosol with a batter gradient of 10%, varying batter heights and varying vegetation cover percentages.

Soil	Height (m)	Gradient (%)	Slope length (m)	Average Annual Erosion (t/ha/y) for percentage vegetation cover (%)													
				0%		30%		40%		50%		60%		70%		80%	
				Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak
Vertosol / Chromosol	10	10	100	163	433	7	27	4	14	2	7	1	4	1	2	0	0
	20	10	200	330	726	20	58	10	29	5	15	3	7	1	4	0	1
	30	10	300	441	864	30	72	15	35	7	18	4	9	2	4	0	1
	40	10	400	514	926	35	77	18	37	9	18	4	9	2	4	0	1
	50	10	500	561	950	39	77	19	37	9	18	4	8	2	4	0	1
	60	10	600	593	954	40	75	19	36	9	17	4	8	2	4	0	1
Kandosol	10	10	100	209	269	22	32	11	16	5	8	3	4	1	2	0	0
	20	10	200	212	249	22	28	11	14	5	7	3	3	1	2	0	0
	30	10	300	200	231	20	24	10	12	5	6	2	3	1	2	0	0
	40	10	400	188	216	19	22	9	11	5	5	2	3	1	1	0	0
	50	10	500	176	202	17	20	8	10	4	5	2	2	1	1	0	0
	60	10	600	167	191	16	19	8	9	4	5	2	2	1	1	0	0

*Orange cells indicate erosion above acceptable threshold values (>5t/ha/y mean, >10t/ha/y peak). Green cells indicate erosion within acceptable threshold values (<5t/ha/y mean, <10t/ha/y peak).

6 DISCUSSION

6.1 Erosion characteristics

The Vertosol/Chromosol is more prone to erosion than the Kandosol, primarily driven by the low effective hydraulic conductivity of the Vertosol/Chromosol. The runoff potential for the Vertosol/Chromosol without vegetation is high, with an average annual rainfall of 552mm producing an average annual runoff value of 305mm. Comparatively, the Kandosol has an average annual runoff value of 74mm when bare. Erosion for both soil types is limited by the capacity of runoff to transport sediment. As such, the higher runoff values for the Vertosol/Chromosol result in an increased rate of erosion compared to the Kandosol.

The erosion modelling indicates that batter height has little impact on the rate of erosion. A slope that erodes above the threshold value at a 60m batter height will still erode above that value at a 20m batter height. This indicates that adjustments to the height of the batters are not predicted to result in a significant difference in erosion performance. This is consistent with a material for which erosion is sediment transport-limited.

Batter gradient has a moderate impact on the rate of erosion. Reduction of batter gradient from 15% to 10% reduced erosion rates by between 50–100%. When considering the impacts of vegetation, the reduction in batter gradient results in a decrease in the percentage of vegetation cover required by 10% for both soil types. As such, alteration of the batter gradient may play a role in the development of an erosionally stable landform.

6.2 Vegetation requirements

Vegetation establishment will be vital if the soils are to be used for rehabilitation. Model predictions indicate that a minimum vegetation groundcover level of 70% is required for the Vertosol/Chromosol and 60% for the Kandosol based on a 15% batter gradient (as is currently adopted for the conceptual rehabilitation landform). The reduction of the batter gradient to 10% is predicted to reduce the cover level requirements by 10% (60% for Vertosol/Chromosol and 50% for Kandosol).

Based on the results, the conceptual rehabilitation design should target vegetation cover levels of 70% across the entire landform. If the batter gradient is reduced to 10%, then a target of 60% would be adequate.

Both the Vertosol/Chromosol and Kandosol soils have the potential to support vegetation. However, vegetation cover levels of 70% may be difficult to reliably achieve. Both soils are potentially prone to structural instability, which may result in elevated erosion rates for these soils.

6.3 Options to reduce erosion

The conceptual rehabilitation design for the OOPDs adopts batter gradients of 15%, and batter heights varying between 20-60m. The proposed rehabilitation strategy is based on developing a reconstituted soil profile comprised of topsoil. For the conceptual rehabilitation design to remain erosionally stable in the long term with topsoil applied to the outer surface, a vegetation groundcover level of 70% is required.

Options to improve erodibility are generally limited to adjustment of the:

- Surface materials applied to the outer surface;
- Batter geometries; and/or
- Vegetation ground cover levels.

Results from the erosion modelling show that adoption of topsoil as a cover material limits the potential options available to improve long-term erosional stability. As the topsoil is highly erodible, adjustment of batter geometries (shorter slope lengths, lower batter heights, shallower batter gradients) will have only a minor impact on long-term erosion rates. Vegetation groundcover is the only remaining option for reduction in erosion rates, and reliance on vegetation cover does present a potential risk.

Alternative options that could be considered include the addition of rock armour (adjustment of surface materials). If fresh, competent, blocky waste rock that is geochemically benign can be sourced, addition of this waste to the topsoil layer (forming a topsoil:rock mix) can reduce the erosion potential of the material. This may provide greater flexibility in potential vegetation cover levels that can be adopted (e.g. reducing the required percentage of vegetation cover). This option should be considered if rehabilitation trials sho that a 70% vegetation cover cannot be reliably established.

7 FURTHER WORKS TO ADDRESS REHABILITATION RISKS

Landloch has identified key risks to rehabilitation of the OOPDs, the cause of these risks and their potential consequences. These are summarised in Table 7. More detail on the further work identified are also provided.

Table 7: Key risks, consequences, causes, and recommended studies to address the risks identified.

Risk	Consequence	Cause	Recommended studies to address risk
Unable to achieve the required vegetation cover level of 70%	Slope failure due to excessive erosion	Topsoil bulk samples provided not representative	Additional characterisation of soil resources, focussing on PSD, dispersion potential, and fertility
		Stockpiled soils become depleted in nutrients prior to placement (compared to undisturbed soils)	Pot trials to assess vegetation growth with addition of fertiliser & other amendments
		Soils prone to structural decline	Field-based trials to assess effectiveness of potential amendments.
		Vegetation cover reduced by fire, drought, or grazing	Assessment of the frequency of these events, the impacts on vegetation cover caused, and the ability of vegetation to recover
		Tree and shrubs species out-compete grasses	Field-based rehabilitation trials
		Failure to maintain sufficient cover when grazing is used as the post-mining land use	Development of a land use management plan that could be employed by local stakeholders to ensure that erosion is controlled, and soil resources are maintained in the long-term
Erosion potential increased	Slope failure due to excessive erosion	Climate change	Assessment of climate change impacts long-term erosion.
Erosion of the landform toe	Slope failure due to scour of the toe	High velocity flood flows	Surface water study of the impacts of the landform location
Uncertainty in current erosion model predictions	Slope failure due to excessive erosion	Currently limited to two soil samples	Ongoing material characterisation, ongoing testing of the erodibility of topsoils, validation of the model predictions through field trials and erosion monitoring

7.1 Vegetation groundcover studies

The baseline characterisation work undertaken for BME has assessed the properties (PSD, dispersion potential) of only two soils. There is a risk that there is considerable variability in the soil properties and that there may be soils that are of poorer quality than those assessed thus far.

Landloch recommends that further PSD, dispersion potential, and fertility assessments be made of the soils to determine whether poorer quality soils exist. This could be achieved by additional sampling (small samples, ~1kg) of stockpiled topsoils and analogue (undisturbed) soils that currently support vegetation, and statistical comparison of their properties.

Additional sampling would also be required if fertilisation of the soils is to be considered. If it is determined that fertilisation would be beneficial, Landloch recommend that trials be established to determine the actual benefit that can be achieved through fertilisation. This could initially include the establishment of a pot trial in which growth media are fertilised at different rates, using different levels of incorporation, and considering single or multiple fertilisations. The results of this would establish the potential benefit of fertilisation and assist in undertaking a cost/benefit analysis, and to determine if a target vegetation cover of 70% can be achieved. From these results, if fertilisation is shown to be beneficial, larger scale field trials could be established to verify that fertilisation of broad areas yields the desired results.

The key limiting factor for the soils is their potential for structural instability. Dispersive soils are at higher risk of soil compaction, surface hardsetting or crusting, and structural decline such as tunnel erosion and surface soil runoff. Water infiltration is typically hindered in highly sodic soils, adversely impacting any plant's ability to uptake water through their roots.

Management of sodic soils typically involves tilling the top 30cm of the soil in conjunction with the addition of calcium via the application of gypsum. Tilling the soil will break up poorly structured soils and generate soil structure, this is of particular use when dealing with hard-set surface soils. Tilling is also required immediately following the application of gypsum. The application of gypsum replaces sodium on clay surfaces with calcium, lowering ESP while increasing salinity.

Organic mulches can be applied, in place of gypsum, immediately following ripping of the top 30cm of soil. The application of mulch is an established practice for managing sodic soils on rehabilitation sites (Gray *et al.* 2006) and may reduce soil erosion as well as promote water infiltration. These potential management methods should be trialled to assess their impact on soil structural stability. Additionally, further testing of the stockpiled topsoils prior to their use in rehabilitation to define the extent of the risk of structural instability may alleviate some of these concerns.

Presence of vegetation – specifically grass cover as distinct from canopy cover – in the long-term is a key requirement for rehabilitation success if slope profiles discussed in this report are adopted. Environmental events such as fire, drought, and over-grazing could potentially adversely impact on the establishment of sufficient cover. Species selection is also critical as establishment of high levels of tree/shrub species may act to reduce surface contact cover.

The risk posed by these possible causes of increased erosion could be considered by:

- Assessment of fire frequency and intensity at BME and recovery rates of vegetation post-fire. This should be coupled with an assessment of erosion risk in the period where the land has reduced cover.
- Assessment of frequency of drought and recovery rates of vegetation post-drought. This should be coupled with an assessment of erosion risk in the period where the land had reduced cover.
- Assessment of likely grazing pressures at BME post-closure and the impact of grazing of vegetation cover levels. This could lead to the establishment of sustainable grazing density values, or identification of the need to control grazing on the waste landforms by other means (e.g., perimeter bunding, access road closure, or surface roughening to restrict livestock access).
- Field-based rehabilitation trials using a range of plant species to determine the ability of grasses to establish and compete with tree and shrub species. These field trials could be set up to also inform the risks related to fire, drought, and grazing.

Where low-intensity grazing is used as the post-mining land use, it will be important that cover is maintained throughout the year, and particularly in the higher erosivity months (December, January and February). A land use management plan could be developed to establish suitable initial land surfaces and to guide ongoing farming practices. Aspects to consider include:

- Establishment of paddocks with appropriate slope lengths;
- Design of contour banks and runoff discharge structures to minimise the risk of erosion of the topsoil resource;
- Consideration of water requirements for specific crops likely to be grown, and assessment of the water storage capacity of the reconstituted soil and waste profiles; and
- Establishment of fertilisation regimes, including use of both artificial fertilisers and other locally available organic matter sources.

7.2 Climate change studies

Climate change has the potential to increase erosion potential over time as rainfall patterns change. The magnitude of the erosion potential change could be considered through additional runoff/erosion modelling using climate sequences adapted to reflect climate change predictions. This study would broadly involve:

- Identifying whether climate change predictions are available for the site, and if so, how the predicted change may impact rainfall patterns, including rainfall totals, rainfall intensities, number of rain day per year, and probability of wet days following dry days and dry days following dry days.
- Use this information to modify the WEPP erosion model climate sequences to account for changes in rainfall patterns. WEPP has the ability to input modified variables for the rainfall totals, intensities, and probabilities outlined above.
- Use the WEPP model to predict long-term erosion under the changed climate scenarios.

7.3 Erosion of the toe

Scour of the toe has the potential to increase the instability of the OOPDs batters. The risk is related to the flow velocity and volumes experienced at the toe of the landform.

A surface water study has been conducted for BME (Engeny 2023) which indicates that scour of the toe is likely to occur on several sections of the landform. Proposed mitigation strategies include the application of rock armour. The size and type of rock armour should be determined based on the critical shear of the surface water flows that are predicted to impact the toe.

7.4 Current limited erodibility data

This erosion study has used the available soil but is limited to two bulk samples, one from an existing stockpile, and the other undisturbed. The act of stripping soils will impact of the physical and chemical characteristics of the materials. As mining progresses, an assessment of the erodibility of the soils available for rehabilitation should be undertaken. The assessment should include testing for:

- Runoff potential;
- Interrill erodibility potential;
- Rill erodibility potential; and
- Sediment properties.

Assessment of long-term erosion is required and this necessitates the use of erosion models. Therefore, the erodibility testing should be used to inform erosion modelling and to improve/validate the model predictions. Once stripping of soils is completed, additional data points will provide improved confidence in the erosion predictions.

8 CLOSING

Test work was undertaken to determine the erosion potential of the soils proposed to be used as sheeting materials for the OOPDs at BME, including:

- Stockpiled topsoil (Vertosol/Chromosol), and
- Undisturbed topsoil (Kandosol).

Both soils have no major limitations from a growth medium perspective based on their chemical properties (pH, EC). Both soils are potentially prone to structural instability. Fertility was not considered as part of this study.

From the results of the erosion modelling it can be predicted that:

- The Vertosol/Chromosol will require establishment of 70% vegetation cover to achieve long-term erosional stability.
- Kandosol will require establishment of 60% vegetation cover to achieve long-term erosional stability.
- Reducing the batter gradient from 15% to 10% will reduce the required vegetation cover levels by 10% for both soil types.

It is concluded that the conceptual rehabilitation design of the OOPDs is likely to be erosionally stable in the long term provided that a vegetation cover level of 70% can be consistently achieved.

The results of this study are based on the two soils tested, and variability in soil characteristics should be considered further. Additional work to address current poorly defined risks has been provided.

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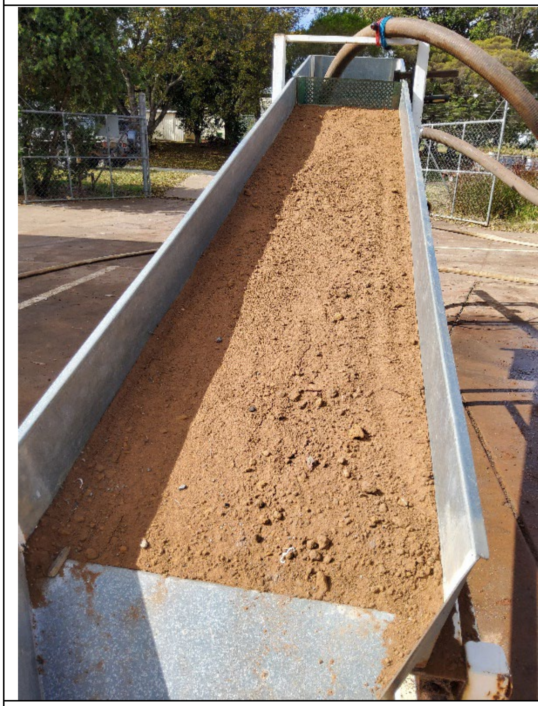
APPENDIX A – FLUME AND RAINSIM PHOTOS

Vertosol/Chromosol (Topsoil)	
	
Rainfall Simulation – Pre-rain (Rep 1)	Rainfall Simulation – Post-rain (Rep 1)
	
Rainfall Simulation – Pre-rain (Rep 2)	Rainfall Simulation – Post-rain (Rep 2)
	
Rainfall Simulation – Pre-rain (Rep 3)	Rainfall Simulation – Post-rain (Rep 3)

Kandosol	
	
Rainfall Simulation – Pre-rain (Rep 1)	Rainfall Simulation – Post-rain (Rep 1)
	
Rainfall Simulation – Pre-rain (Rep 2)	Rainfall Simulation – Post-rain (Rep 2)
	
Rainfall Simulation – Pre-rain (Rep 3)	Rainfall Simulation – Post-rain (Rep 3)

Vertosol/Chromosol prior to simulation	Vertosol/Chromosol post simulation
	
Flumes 10%	Flumes 10%
	
Flumes 20%	Flumes 20%

Vertosol/Chromosol prior to simulation	Vertosol/Chromosol post simulation
	
Flumes 30%	Flumes 30%
Kandosol prior to simulation	**Kandosol post simulation**
	
Flumes 10%	Flumes 10%

Kandosol prior to simulation	Kandosol post simulation
	
Flumes 20%	Flumes 20%
	
Flumes 30%	Flumes 30%

Ref No.	Domain	PMLU	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R1	OOPD	Low intensity	Health and Safety	All	Access to landform containing excessively steep slopes/drop-offs results in human injury or death.	• Poor landform design includes steep drop-offs. • Poor landform design results in excessive erosion and the generation of steep drop-offs. • Poor understanding of material characteristics results in excessive erosion and the production of steep drop-offs.	Injury or death.	Unlikely	Major	Medium	• Landform constructed outside of the pit zone of instability. • Final designs exclude gradients that exceed 15%. • Auditing during construction to confirm final landforms meet design requirements.	Rare	Moderate	Low	• Annual site inspection. • Geotechnical audit at post closure year 5.
R2	OOPD	Low intensity	Physical Stability	All	Erosion following significant wet weather events results in landform instability.	• Inadequate materials characterisation during planning, operations and construction phases. • Poor landform design results in concentrated stormwater flows. • Landform construction and rehabilitation does not follow the design, resulting in concentrated stormwater flows. • Landform design uses erosive materials on the batters. • Landform construction and rehabilitation undertaken with minimal survey QA/QC resulting in concentrated stormwater flows. • Inadequate maintenance of rehabilitation materials balance. • Landform designs do not account for materials balance (i.e. more capping material required than available).	• Landform instability. • Lack of vegetation establishment on OOPD. • Exposure of problematic waste materials (e.g. PAF) due to inappropriate encapsulation. • Erosion and downstream sedimentation. • Reduced surface water quality. • Reduced visual amenity. • Increased fugitive dust emissions.	Likely	Moderate	High	• Problematic waste managed in accordance with Mineral Waste Management Plan (MWMP). • Material / waste characteristics and inventory (as required). • Landform designed to minimise and control stormwater and sediment. • Landform design uses non-erosive materials on the outer surfaces. • Landform constructed in accordance with QA/QC plan (survey). • Bulk earthworks to achieve required landform and slopes as per design. • General reshaping and pushing / trimming to achieve final landform. • Fill in associated sediment dams when no longer required as per updated Erosion and Sediment Control Plan (ESCP). • Design includes appropriate stormwater management - installation of long term erosion and sediment control systems/features. • Remediate subsidence and erosion before sourcing, delivering, and spreading growth media. • Apply ameliorants and fertilisers to growth media before and after application (based on QA/QC process). • Trim/rip, apply seeding and irrigate. • If possible, rehabilitation trials on areas that have been progressively rehabilitated.	Unlikely	Minor	Low	Site specific rehabilitation performance monitoring that includes identification and quantification of common erosion parameters (e.g., geomorphic assessment).
R3	OOPD	Low intensity	Hydrology	All	Rainfall events result in chronic saline or alkaline drainage.	• Inadequate materials characterisation during operation and construction. • Poor encapsulation of hazardous materials during construction and rehabilitation. • Poor OOPD construction results in exposure of hazardous materials. • Inadequate final landform designs. • Inadequate maintenance of rehabilitation materials balance. • Landform designs do not account for materials balance (i.e. more capping material required than available).	• Lack of vegetation establishment on OOPDs. • Loss of vegetation in surrounding area. • Degraded surface water quality for the receiving environment. • Reduced visual amenity.	Possible	Moderate	Medium	• Ongoing materials characterisation during operations and management in accordance with MWMP. • Maintenance of a materials inventory/balance during operations. • Survey of rejects location. • Final landform designs account for material characteristics, with a minimum capping depth of 5m for rejects using geochemically benign and erosion resistant overburden. • Implementation of an appropriate construction QA/QC program to ensure that the OOPD is constructed in accordance with design criteria. This will involve dedicated site supervision by a AQP and survey. • Fill in associated sediment dams when no longer required as per updated ESCP.	Unlikely	Minor	Low	Continuation of Receiving Environment Monitoring Program (REMP) and Water Management Plan (WMP) as adapted from operations to post closure.

Ref No.	Domain	PMLU	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R4	OOPD	Low intensity	Hydrogeology	All	Poor encapsulation of PAF materials results in seepage OOPDs contaminated water to groundwater resources.	• Inadequate materials characterisation during operation and construction. • Poor encapsulation of hazardous materials during construction and rehabilitation. • Poor OOPD construction results in exposure of hazardous materials. • Inadequate final landform designs. • Inadequate maintenance of rehabilitation materials balance. • Landform designs do not account for materials balance (i.e. more capping material required than available).	• Degraded groundwater quality contribution to the Southern Void. • Degraded groundwater quality for future third party users of the impacted aquifers.	Possible	Moderate	Medium	• Ongoing materials characterisation during operations and management in accordance with MWMP. • Maintenance of a materials inventory/balance during operations. • Survey of rejects location. • Final landform designs account for material characteristics, with a minimum capping depth of 5m for rejects using geochemically benign and erosion resistant overburden. • Implementation of an appropriate construction QA/QC program to ensure that the OOPD is constructed in accordance with design criteria. This will involve dedicated site supervision by a AQP and survey.	Unlikely	Minor	Low	Continuation of Groundwater Monitoring and Management Plan (GMMP) as adapted from operations to post closure.
R5	OOPD	Low intensity	Ecosystem Function	Rehabilitation	Vegetation fails to establish on rehabilitated landform or does not meet the target vegetation criteria.	• Inadequate materials characterisation resulting in the use of materials that are hostile to vegetation growth. • Poor landform design allows for the washing of seed/vegetation downslope. • Poor selection of vegetation species. • Poor revegetation methodology. • Vegetation unable to establish due to grazing by native and/or domestic species. • Extended drought period inhibits vegetation establishment. • Unrealistic completion criteria.	• Landform unable to meet post closure land use criteria. • Loss of habitat or beneficial land use. • Reduced visual amenity. • Increase in fugitive dust emissions. • Reduced water quality in the receiving environment. • Failure to meet completion criteria.	Likely	Moderate	High	• Rehabilitation trials and/or benchmarking assessment, if required, to inform final landform designs. • Material characterisation and accounting demonstrates adequate volumes of suitable growth medium. • Implement Rehabilitation Management Plan (including grazing trials if required). • Landform design minimises drainage velocities and associated downslope loss of seed/vegetation. • Construction of long term erosion and sediment control systems/features as per closure ESCP based on achieved groundcover and landform stability. • Remediation of subsidence and erosion issues before sourcing, delivering, and spreading growth media. • Earthworks and rehabilitation QA/QC program. • Growth medium and/or spoil ameliorated in accordance with geochemical/nutritional requirements. • Appropriate species selection that incorporates a mix of local, native species as determined through trials/benchmarking assessments conducted at nearby mines. •Construction of temporary fencing to allow vegetation to establish through restriction of access by grazing species.	Possible	Minor	Medium	• Rehabilitation Performance Monitoring Program. • Weed and pest monitoring (abundance of declared weeds is less than reference sites). • Fire and drought assessment.
R6	Northern Pit (partial backfill)	Low intensity	Health and Safety	All	Access to backfilled pit containing excessively steep slopes/drop-offs results in human/fauna injury or death.	• Unrestricted access to the void.	Human or fauna injury or death.	Unlikely	Major	Medium	• Redesign of final landform has removed the partial backfill of the Northern Pit and it is to be recontoured to blend into the surrounding landform, therefore eliminating the risk. ~~Previously considered treatments to reduce risk below high:~~ ~~• Construction of safety bunds at 2 m high, base width of 5 m from unweathered, freely-draining, end-dumped rockfill at a minimum 20 m offset from the depression perimeter as per the void closure plan.~~ ~~• Backfill to 270RL (water level based on groundwater conceptual modelling).~~	Rare	Minor	Risk Eliminated	Annual site inspections to identify any signs of unauthorised access.

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Broadmeadow East Mine
Progressive Rehabilitation and Closure Risk Assessment

RPMGLOBAL

Ref No.	Domain	PMLU	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R7	Northern Pit	Low intensity	Physical Stability	All	Significant wet weather event destabilises pit walls and slopes.	• Inadequate stormwater drainage design concentrates flows towards the pit. • Absence of diversion bunds where required. • Pit walls constructed of unstable geology.	• Landform instability. • Lack of vegetation establishment on walls and slopes. • Exposure of problematic waste materials (e.g. PAF). • Reduced surface water quality. • Increased fugitive dust emissions.	Likely	Major	High	• Redesign of final landform has removed the partial backfill of the Northern Pit and it is to be recontoured to blend into the surrounding landform, therefore eliminating the risk. ~~Previously considered treatments to reduce risk below high:~~ ~~• Final landform design developed with ample consideration to material characteristics.~~ ~~• Site wide drainage and flood assessment with implementation of associated recommendations/management measures.~~ ~~• Mine site closure drainage design minimises concentrated stormwater flows.~~ ~~• Landform uses slopes less than 15%, to be re-assessed and designed as per the chemical and physical characteristics of the site.~~ ~~• Void backfilled to 270RL (water level based on groundwater conceptual modelling).~~ ~~• Structural, geotechnical and hydraulic factors determined based on the physical and chemical characteristics of the site.~~ ~~• Reshaping, trimming and construction of long-term drainage/ESC.~~	Possible	Moderate	Risk Eliminated	• Landform compliance audit against design criteria by AQP. •Rehabilitation performance monitoring, including erosion parameters.
R8	Northern Pit	Low intensity	Chemical Stability	All	Surface run off, discharge or seepage of hazardous material from mine voids results in an exceedance of receiving environment contaminant limits.	Failure to remove mine affected water or contaminated sediments from mine void prior to closure.	• Lack of vegetation establishment on mine void. • Loss of vegetation in surrounding area. • Degraded groundwater and surface water quality.	Possible	Moderate	Medium	• Redesign of final landform has removed the partial backfill of the Northern Pit and it is to be recontoured to blend into the surrounding landform, therefore eliminating the risk. ~~Previously considered treatments to reduce risk below high:~~ ~~• Removal of all mine affected water.~~ ~~• Contaminated sediments removed.~~ ~~• Installation of certified contours and drains as per design by an AQP (CPESC).~~ ~~• Cover exposed coal seams with 2 or more meters of geochemically benign material.~~ ~~• Problematic waste managed in accordance with dedicated MWMP.~~ ~~• Removal of all mine affected water for use in dust suppression prior to backfilling.~~ ~~• Removal of potential contaminated sediments that may be identified in the land contamination survey.~~	Unlikely	Minor	Risk Eliminated	• Materials inventory. • Contaminated land survey conducted by an AQP. • Continuation of REMP, GMMP and WMP as adapted from operations to post closure.
R9	Northern Pit	Low intensity	Ecosystem Function	Rehabilitation	Rehabilitation fails to link with terrestrial vegetation and does not meet the species richness criteria.	• Inadequate materials characterisation during operations/construction results in use of materials that are hostile to vegetation growth. • Poor landform design results in high energy stormflows that wash seed/vegetation downslope. • Poor selection of vegetation species. • Poor revegetation methodology. • Poor water quality in pit void restricts aquatic species. • Extended drought period inhibits vegetation establishment. • Unrealistic completion criteria.	• Landform unable to meet post closure land use criteria. • Disconnect of terrestrial vegetation linkages. • Loss of habitat. • Reduced visual amenity.	Likely	Moderate	High	• Redesign of final landform has removed the partial backfill of the Northern Pit and it is to be recontoured to blend into the surrounding landform, therefore eliminating the risk. ~~Previously considered treatments to reduce risk below high:~~ ~~• Rehabilitation trials and/or benchmarking assessment if required.~~ ~~Implement the Rehabilitation Management and Monitoring Plans.~~ ~~• Backfill to 270 RL.~~ ~~• Soil assessment prior to use in rehabilitation.~~ ~~• Reshaping, trimming and construction of long-term drainage/ESC.~~ ~~• Establishment of a mix of perennial grasses suitable for grazing in the area.~~	Possible	Minor	Risk Eliminated	• Rehabilitation Performance Monitoring Program. • Weed and pest monitoring (abundance of declared weeds is less than reference sites). • Fire and drought assessment.
R10	Central Pit	Low intensity	Health and Safety	Closure	Central Pit not completely backfilled.	• Insufficient volumes of material to fill pit void completely. • Failure to calculate sufficient material in landform design planning. • Landform designs do not account for materials balance (i.e. more capping material required than available).	Unauthorised access results in potential human or fauna injury or death.	Possible	Major	High	• Ongoing materials characterisation and accounting during operations. • Final landform and associated backfilling design accounts for material characteristics and volumes.	Unlikely	Moderate	Medium	• Annual site inspections.

Ref No.	Domain	PMLU	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R11	Central Pit	Low intensity	Hydrology	Closure	Erosion of Central Pit area following significant wet weather event results in increasing landform instability.	• Inadequate materials characterisation and accounting during planning, operations and construction phases. • Poor landform design results in concentrated stormwater flows. • Landform construction and rehabilitation not according to design, resulting in concentrated stormwater flows. • Landform construction and rehabilitation undertaken with minimal survey QA/QC resulting in concentrated stormwater flows.	• Landform instability. • Lack of vegetation establishment on WRD. • Exposure of problematic waste materials (e.g. PAF). • Erosion and downstream sedimentation. • Reduced surface water quality.	Likely	Moderate	High	• Landform designed, reshaped/re-profiled to minimise and control stormwater and sediment. • Installation of long term erosion and sediment control systems/features. • Hydrological modelling to inform design criteria. • Remediate subsidence and erosion issues before sourcing, delivering, and spreading growth media. • Rejects buried above the expected (post closure) groundwater level, if required. • Backfill associated sediment dams. • Non-erosive materials used to sheet outer surfaces. • Rehabilitation earthworks QA/QC program. • Landform constructed in accordance with design. • Assessment of hydraulic properties of backfilled material conducted by AQP to ascertain potential for instability.	Unlikely	Minor	Low	• Landform compliance audit against design criteria by an AQP. • Rehabilitation performance monitoring, including erosion parameters. • Continuation of REMP and WMP as adapted from operations to post closure.
R12	Central Pit	Low intensity	Hydrogeology	Closure	Poor handling and encapsulation of PAF materials in the Central Pit area results in seepage of contaminated water to groundwater resources.	• Inadequate materials characterisation and accounting during planning, operations and construction phases. • Poor landform design results in concentrated stormwater flows. • Landform construction and rehabilitation not according to design, resulting in long term pooling areas. • Landform construction and rehabilitation undertaken with minimal survey QA/QC resulting in concentrated stormwater flows.	• Unmitigated seepage. • Ongoing erosion that creates seepage pathways. • Exposure of problematic waste materials (e.g. PAF). • Unusable for future users. • Reduced groundwater quality.	Possible	Major	High	• Landform designed, reshaped/re-profiled to minimise and control stormwater and sediment. • Installation of long term erosion and sediment control systems/features. • Hydrological modelling to inform design criteria. • Remediate subsidence and erosion issues before sourcing, delivering, and spreading growth media. • Rejects buried above the expected (post closure) groundwater level, if required. • Non-erosive materials used to sheet outer surfaces. • Rehabilitation earthworks QA/QC program. • Landform constructed in accordance with design. • Assessment of hydraulic properties of backfilled material conducted by AQP to ascertain potential for instability.	Unlikely	Moderate	Medium	Continuation of GMMP as adapted from operations to post closure.
R13	Central Pit	Low intensity	Chemical Stability	Closure	Surface runoff from backfilled Central Pit area causes exceedance of receiving environment contaminant limits.	Poor landform design results in concentrated stormwater flows that expose geochemically hostile materials.	• Lack of vegetation establishment over backfilled pit. • Loss of vegetation in surrounding area. • Degraded groundwater and surface water quality. • Failure to meet target PMLU criteria.	Likely	Moderate	High	• Installation of certified contours and drains as per design by an AQP (CPESC). • Problematic waste managed in accordance with dedicated MWMP. • Landform design encapsulates problematic materials and promotes low energy stormwater runoff.	Possible	Minor	Medium	Continuation of REMP and WMP as adapted from operations to post closure.
R14	Central Pit	Low intensity	Ecosystem Function	Rehabilitation	Vegetation in Central Pit area fails to establish on rehabilitated landform or does not meet the target vegetation criteria.	• Inadequate materials characterisation resulting in use of materials that are hostile to vegetation growth. • Poor revegetation methodology. • Vegetation unable to establish due to grazing by native and/or domestic species. • Extended drought period inhibits vegetation establishment. • Unrealistic completion criteria.	• Landform unable to meet post closure land use criteria. • Loss of habitat/beneficial land use. • Reduced visual amenity. • Increase in fugitive dust emissions.	Likely	Major	High	• Continued waste characterisation and inventory. • Growth medium demonstrated to be appropriate for selected vegetation species (and vice versa). • Rehabilitation trials and/or benchmarking to determine most effective rehabilitation methodology and seed species if required. • Completion criteria are achievable based on assessment of trial data and local benchmarking.	Possible	Minor	Low	Rehabilitation performance assessment.

Ref No.	Domain	PMLU	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R15	Southern Void	Water storag	Health and Safety	All	Access to water storage in the Southern Void results in human or fauna injury or death.	Poorly restricted access to the water storage.	Unrestricted access to water storage resulting in potential human, stock or fauna injury or death.	Possible	Major	High	• Safety bund constructed at 2 m high, with a base width of 5 m from unweathered, freely-draining, end dumped rockfill at a minimum 20 m offset from the pit zone of instability as per the closure plan. • Fence entire perimeter and bund to high wall areas. • No public access to high wall or end wall areas. • Minimise void area. • Stabilise walls and slopes as per the void closure plan. • Design and construct the void as per the void closure plan. • Partial backfill according to the groundwater level and as per the baseline groundwater assessment. • Drainage promotes runoff into the void. • Backfill above the groundwater level (water level based on conceptual modelling).	Possible	Minor	Medium	Annual site inspections.
R16	Southern Void	Water storag	Chemical Stability	All	Uncontained Southern Void waters impact surface or groundwater and exceed receiving environment contaminant limits.	• Poor landform design results in concentrated stormwater flows. • Poor landform design does not allow sufficient freeboard. • Poor hydrogeological understanding of local aquifers. • Inadequate pit lake modelling (water balance and hydrochemistry).	• Reduction in aquatic fauna health. • Reduced surface and groundwater quality. • Reduced long term water quality for livestock consumption.	Possible	Major	High	• Final void located outside of the Isaac River floodplain, as defined under the EP Act. • Pit wall geochemical characterisation. • Development of a robust hydrogeological model. • Long term pit lake water modelling (geochemical and water balance). • Coal seams to be treated, removed or covered in the backfilling process. • Installation of certified contours and drains as per design by an AQP (CPESC). • Conduct a water balance study to assess the void surface and groundwater interactions. • Conduct effective measures to avoid generation or release of saline drainage and acid rock drainage.	Possible	Minor	Medium	Surface and groundwater quality monitoring, with continual revision of the groundwater/pit lake model.
R17	Southern Void	Water storag	Physical Stability	All	Erosion from the water strage ares following significant wet weather events results in increasing landform instability.	• Inadequate materials characterisation during planning, operations and construction phases. • Poor landform design results in concentrated stormwater flows. • Landform construction and rehabilitation not according to design, resulting in concentrated stormwater flows. • Landform construction and rehabilitation undertaken with minimal survey QA/QC resulting in concentrated stormwater flows. • Inadequate maintenance of rehabilitation materials balance. • Landform designs do not account for materials balance (i.e. more capping material required than available). • Inadequate stormwater drainage design concentrates flows towards the pit. • Absence of diversion bunds where required. • Pit walls constructed of unstable geology.	• Landform instability. • Lack of vegetation establishment. • Concentrated stormwater flows causing erosion and downstream sedimentation. • Reduced surface water quality. • Reduced visual amenity. • Increased fugitive dust emissions. • Failure to meet target PMLU criteria.	Likely	Major	High	• Landform design uses non-erosive materials on the outer surfaces. • Landform constructed in accordance with QA/QC plan (survey). • Final shape implemented as per rehabilitation and management strategies included in the void closure plan. • Structural, geotechnical and hydraulic factors based on the physical and chemical characteristics of the site. • Long term erosion and sediment control systems/features installed as per closure ESCP based on achieved groundcover and landform stability • Structural, geotechnical and hydraulic factors determined based on the physical and chemical characteristics of the site. • Drainage measures and structures have been appropriately established and are directing overland flow away from the highwall edge	Possible	Minor	Medium	• Geotechnical report and certification from an experienced person AQP that the area has achieved stable condition • Annual site inspections

Ref No.	Domain	PMLU	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R18	Southern Void	Water storag	Hydrology	Closure	The soutern void long term water quality target is not achieved resulting in a final landform that does maintain its PMLU.	• Poor understanding of local geology / pit wall geochemical characteristics. • Inadequate materials characterisation resulting in higher rates of contamination than expected. • Poor long term water quality. • Groundwater contamination due to unexpected change from a sink to a source. • Pit lake does not meet long term equilibrium and overflows into the surrounding environment. • Vegetation on 14% slope is unable to establish due to grazing by native and/or domestic species.	• Landform unable to meet post closure land use criteria. • Long term impacts to the receiving environment.	Likely	Major	High	• Design final slope angles of the high, low and end walls. • Implement designs and recommendations from the final void design plan. • Manage long term water quality for livestock consumption. • Backfill to above the regional groundwater level. • Treat or remove exposed coal seams. • Develop specific rehabilitation strategies that includes monitoring, surveying, stability analysis and reporting. • Surface water quality of the receiving environment as per water management plan	Possible	Moderate	Medium	• Annual site inspections. • Surface and groundwater quality monitoring, with continual revision of the groundwater/pit lake model. • Aquatic, flora and fauna ecological monitoring
R19	Water Management Infrastructures (to be rehabilitated)	Low intensity	Health and Safety	All	Associated infrastructure is not adequately decommissioned and rehabilitated.	• Inadequate rehabilitation of water storage infrastructure. • Failure to calculate sufficient backfill material in landform design planning. • Landform designs do not account for materials balance (i.e. more capping material required than available). • Residual infrastructure left after closure, posing a risk to human/fauna health.	Potential human or stock injury.	Unlikely	Minor	Low	• Remove all associated infrastructure, including fencing and signage. • General reshaping and pushing/trimming to achieve final landform design.	Rare	Insignificant	Low	• Annual site inspections.
R20	Water Management Infrastructures (to be rehabilitated)	Low intensity	Physical Stability	All	Erosion following significant wet weather events results in increasing landform instability in operational water storage areas.	• Inadequate materials characterisation during planning, operations and construction phases. • Poor landform design results in concentrated stormwater flows. • Landform construction and rehabilitation not according to design. • Landform design uses erosive materials. • Landform construction and rehabilitation undertaken with minimal survey QA/QC resulting in concentrated stormwater flows. • Inadequate maintenance of rehabilitation materials balance. • Landform designs do not account for materials balance (i.e. more capping material required than available).	• Landform instability. • Lack of vegetation establishment. • Concentrated stormwater flows causing erosion and downstream sedimentation. • Reduced surface water quality. • Reduced visual amenity. • Increased fugitive dust emissions. • Failure to meet target PMLU criteria.	Possible	Minor	Medium	• Dewater (for use in dust suppression) prior to rehab if applicable. • Installation of certified contours and drains as per design by an AQP (CPESC). • Final landform and associated backfilling design accounts for material characteristics and volumes.	Unlikely	Insignificant	Low	• Annual site inspections.
R21	Water Management Infrastructures (to be rehabilitated)	Low intensity	Chemical Stability	All	Surface runoff and/or discharge or seepage of hazardous material from rehabilitated water storage infrastructure results in an exceedance of receiving environment contaminant limits.	Failure to remove mine affected water or contaminated sediments from water storage infrastructure (where necessary) prior to closure.	• Lack of vegetation establishment on mine void. • Loss of vegetation in surrounding area. • Degraded groundwater and surface water quality. Failure to meet target PMLU criteria.	Possible	Moderate	Medium	Remove all potentially hazardous water/sediment from the facility prior to rehabilitation works.	Unlikely	Minor	Low	• Annual site inspections.
R22	Water Management Infrastructures (to be rehabilitated)	Low intensity	Ecosystem Function	Decommissioning	Rehabilitation does not meet the target vegetation criteria in previous water storage areas.	• Inadequate materials characterisation resulting in the use of materials that are hostile to vegetation growth. • Poor revegetation methodology. • Vegetation unable to establish due to grazing by native and/or domestic species.	• Landform unable to meet post closure land use criteria. • Loss of habitat. • Reduced visual amenity.	Likely	Major	High	• Conduct land contamination investigation. • Remove sediment or bury insitu.	Unlikely	Minor	Low	• Annual site inspections. • Rehabilitation performance assessment.
R23	Infrastructure (MIA/explosives/exploration)	Low intensity	Health and Safety	All	Access to landform containing unrehabilitated drill holes results in human injury or fauna death.	• Poor drill hole rehabilitation. • Hazardous material exposure post closure.	• Fauna (i.e. livestock) injury or death.	Unlikely	Moderate	Medium	• Surface preparation in line with surrounding topography. • Rehabilitate all exploration drill holes in accordance with the applicable Australian Standard or guideline. • Progressive rehabilitation. • Drill holes grouted and casings cut to ground level.	Rare	Minor	Low	• Rehabilitation performance assessment.. • Drill hole audit schedule. • Decommissioning audit. • Weed and pest monitoring.

Ref No.	Domain	PMLU	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R24	Infrastructure (MIA/explosives/exploration)	Low intensity	Chemical Stability	All	Surface run off, discharge or seepage of hazardous material from infrastructure areas results in an exceedance of receiving environment contaminant limits.	Failure to remove contamination sources.	• Lack of vegetation establishment. • Loss of vegetation in contaminated areas. • Degraded groundwater and surface water quality. • Failure to meet PMLU.	Possible	Moderate	Medium	• Conduct land contamination investigation. • Remove buildings. • Remove and proper disposal of road surface and fencing. • Disconnect services, empty tanks, and licenced removal of contaminated water. • Remove and properly dispose of general and regulated waste. • Remove imported fill used to raise MIA (treat as contaminated) and encapsulate in backfilled pit or open waste dumps. • Contaminated soil identified and removed in accordance with relevant guidelines and standards.	Unlikely	Minor	Low	• Contaminated land survey. • Water quality monitoring - receiving environment contaminant limits not exceeded.
R25	Infrastructure (MIA/explosives/exploration)	Low intensity	Ecosystem Function	Closure	Rehabilitation does not meet the target vegetation criteria in previous infrastructre areas	• Inadequate materials characterisation resulting in use of materials that are hostile to vegetation growth. • Poor revegetation methodology, practices or supervision. • Vegetation unable to establish due to grazing by native and/or domestic species.	• Failure to establish vegetation and meet completion criteria. • Excessive runoff during wet weather events. • Fugitive dust. • Loss of habitat. • Reduced visual amenity.	Likely	Major	High	• All disturbance areas will be contour ripped to break up compaction. • Seeding and ameroation if required from any soil sampling program. • Monitoring and reporting.	Unlikely	Minor	Low	• Rehabilitation performance assessment.
R26	Roads and tracks	Low intensity	Health and Safety	Decommissioning	Residual roads, tracks, signage or fencing remain post decommissioning.	• Failure to remove roads, tracks, signage or fencing. • Poorly managed decommissioning. • Poorly budgeted decommissioning.	• Public safety, with potential for fatal injury. • Reduced visual amenity.	Possible	Moderate	Medium	• Surface preparation. • Installation of long term erosion and sediment control systems where required. • Source, cart and spread growth media. • Rip and seed. • Decommissioning undertaken by a suitably qualified contractor and managed by an experienced mine site demolition and decommissioning contractor. • Maintain a detailed decommissioning cost estimate as part of ongoing closure liability cost estimates.	Unlikely	Minor	Low	• Subsidence and erosion monitoring. • Decommissioning audit.
R27	Roads and tracks	Low intensity	Chemical Stability	Decommissioning	Surface water run from areas where there was roads and tracks off results in an exceedance of receiving environment contaminant limits.	Failure to remove contamination sources.	• Lack of vegetation establishment. • Loss of vegetation in contaminated areas. • Degraded surface water quality. • Failure to meet the establishment of the PMLU.	Possible	Minor	Medium	• AQP to conduct land contamination investigation. • Contaminated soil identified and removed in accordance with relevant guidelines and standards.	Unlikely	Minor	Low	• Contaminated land survey. • Surface water quality monitoring - do not exceed limits specified in EA or monitoring plan.
R28	Roads and tracks	Low intensity	Ecosystem Function	Closure	Soils where there were roads and track remain heavily compacted.	Poor rehabilitation practices and/or supervision.	• Lack of vegetation establishment. • Loss of vegetation in contaminated areas. • Reduced visual amenity	Likely	Moderate	High	• Progressive rehabilitation • General reshaping and pushing trimming to achieve pre-disturbance contours (including re-establishment of bed and banks). • Installation of long terms erosion and sediment control systems where required. • Source, cart and spread growth media. • Rip and seed. • Monitoring and reporting.	Unlikely	Minor	Low	• Rehabilitation performance assessment.

Low Initial Risk			Low Residual Risk				
Medium Initial Risk			Medium Residual Risk				
High Initial Risk			High Residual Risk				

Risk Ref.	Risk Source or Event	Proposed Controls and Treatments*	Reasons for selecting treatment option	Resource Requirements	Performance Measures and Constraints	Monitoring and Reporting	Timing and Scheduling
R1	Access to landform containing excessively steep slopes/drop-offs results in human injury or death.	• Landform constructed outside of the pit zone of instability. • Final designs exclude gradients that exceed 15%. • Auditing during construction to confirm final landforms meet design requirements.	These treatments were considered the most effective measures to provide a safe, stable, non-polluting with a self sustaining ecosystem.	**Landform Construction** Suitably qualified personnel and equipment to manage earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Landform Monitoring** Suitably qualified personnel and equipment to monitor profile and stability.	**Performance Measure:** Safe, stable self sustaining landform. **Constraint:** The performance measure is aimed at future use by authorised persons traversing the land by walking, horseback or ATV's.	Monitoring will consist of both visual (field-based assessments) and GIS (remote sensing) technologies (such as LiDAR) to ensure the final landform is safe, stable. Details can be found in Table 3-31 Final Landform Monitoring	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan, the Rehabilitation Management Plan (RMP) and Rehabilitation Monitoring Program.
R2	Erosion following significant wet weather events results in landform instability.	• Problematic waste managed in accordance with Mineral Waste Management Plan (MWMP). • Material / waste characteristics and inventory (as required). • Landform designed to minimise and control stormwater and sediment. • Landform design uses non-erosive materials on the outer surfaces. • Landform constructed in accordance with QA/QC plan (survey). • Bulk earthworks to achieve required landform and slopes as per design. • General reshaping and pushing / trimming to achieve final landform. • Fill in associated sediment dams when no longer required as per updated Erosion and Sediment Control Plan (ESCP). • Design includes appropriate stormwater management - installation of long term erosion and sediment control systems/features. • Remediate subsidence and erosion before sourcing, delivering, and spreading growth media. • Apply ameliorants and fertilisers to growth media before and after application (based on QA/QC process). • Trim/rip, apply seeding and irrigate. • If possible, rehabilitation trials on areas that have been progressively rehabilitated.	These treatments were considered the most effective measures to minimise the opportunity for erosion following a significant deluge and maintain a safe, stable, non-polluting with a self sustaining ecosystem.	**Landform Construction** Suitably qualified personnel and equipment to manage earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Landform Monitoring** Suitably qualified personnel and equipment to monitor profile and stability.	**Performance Measure:** The following parameters are within acceptable standards following significant wet weather events: • No active areas of rill or gully erosion. • Measurable erosion not exceeding approved erosion rate. • Drainage follows appropriate drainage paths. • No major slumping. • No exposed hazardous materials. **Constraint:** Measurement of this aspect is constrained by the significance of wet weather events following completion of final landform.	Annual survey of rehabilitation area to ensure landform conforms to completion criteria for 5 years. On the 5 year a geotechnical audit will be completed.	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan, the Rehabilitation Management Plan (RMP) and Rehabilitation Monitoring Program.
R3	Rainfall events result in chronic saline or alkaline drainage.	• Ongoing materials characterisation during operations and management in accordance with MWMP. • Maintenance of a materials inventory/balance during operations. • Survey of rejects location. • Final landform designs account for material characteristics, with a minimum capping depth of 5m for rejects using geochemically benign and erosion resistant overburden. • Implementation of an appropriate construction QA/QC program to ensure that the OOPD is constructed in accordance with design criteria. This will involve dedicated site supervision by a AQP and survey. • Fill in associated sediment dams when no longer required as per updated ESCP.	These treatments were considered the most effective measures to minimise the opportunity for contamination of drainage water following a significant deluge and maintain a safe, stable, non-polluting with a self sustaining ecosystem.	**Landform Construction** Suitably qualified personnel and equipment to manage earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Landform Monitoring** Suitably qualified personnel and equipment to monitor profile and stability.	**Performance Measure:** No evidence of surface water impacts on visual amenity, surface water quality or vegetation. **Constraint:** Measurement of this aspect is constrained by the significance of wet weather events following completion of final landform.	• Receiving water quality indicators do not exceed specified criteria limits as per BME Receiving Environment Monitoring Program (REMP). • Hydrological survey (i.e., LiDAR). • Drainage and runoff assessments to identify and rectify converging flow paths. • Annual visual survey of rehabilitation area to ensure exposure of hazardous material or evidence of contaminated drainage. • Certification by an AQP that rejects have been managed in accordance with design criteria (survey and QA/QC report audits).	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of water monitoring scheduling is outlined in Section 3.7 of PRCP Part B.

Low Initial Risk	Low Residual Risk
Medium Initial Risk	Medium Residual Risk
High Initial Risk	High Residual Risk

Risk Ref.	Risk Source or Event	Proposed Controls and Treatments*	Reasons for selecting treatment option	Resource Requirements	Performance Measures and Constraints	Monitoring and Reporting	Timing and Scheduling
R4	Poor encapsulation of PAF materials results in seepage OOPDs contaminated water to groundwater resources.	• Ongoing materials characterisation during operations and management in accordance with MWMP. • Maintenance of a materials inventory/balance during operations. • Survey of rejects location. • Final landform designs account for material characteristics, with a minimum capping depth of 5m for rejects using geochemically benign and erosion resistant overburden. • Implementation of an appropriate construction QA/QC program to ensure that the OOPD is constructed in accordance with design criteria. This will involve dedicated site supervision by a AQP and survey.	These treatments were considered the most effective measures to ensure the encapsulation of waste material remains effective in not providing a pathway for leachate to enter the surrounding environment.	**Landform Construction** Suitably qualified personnel and equipment to manage material characterisation, earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Groundwater Monitoring** Material and personnel for installation of a suitable groundwater monitoring network. Suitably qualified personnel and equipment to monitor groundwater quality.	**Performance Measure:** No evidence of unsuitable groundwater pressures, levels or quality. **Constraint:** Measurement of this aspect is constrained by the movement of the groundwater and impacts may not be obvious immediately. Finding the source of any contamination may require additional monitoring bores to be installed.	• Monitoring and sampling of groundwater conducted in line with the latest edition of the administering authority's Monitoring and Sampling Manual. • Sampling and testing to ensure water quality limits are not exceeded (including in-situ pH, EC and suspended solids, metals/metalloids and total petroleum hydrocarbons).	The final landforms to restrict impact on the groundwater will be managed through the medium and long-term Mine Plan, Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of the groundwater monitoring scheduling is outlined in Section 3.7 of PRCP Part B.
R5	Vegetation fails to establish on rehabilitated landform or does not meet the target vegetation criteria.	• Rehabilitation trials and/or benchmarking assessment, if required, to inform final landform designs. • Material characterisation and accounting demonstrates adequate volumes of suitable growth medium. • Implement Rehabilitation Management Plan (including grazing trials if required). • Landform design minimises drainage velocities and associated downslope loss of seed/vegetation. • Construction of long term erosion and sediment control systems/features as per closure ESCP based on achieved groundcover and landform stability. • Remediation of subsidence and erosion issues before sourcing, delivering, and spreading growth media. • Earthworks and rehabilitation QA/QC program. • Growth medium and/or spoil ameliorated in accordance with geochemical/nutritional requirements. • Appropriate species selection that incorporates a mix of local, native species as determined through trials/benchmarking assessments conducted at nearby mines. •Construction of temporary fencing to allow vegetation to establish through restriction of access by grazing species.	Ensuring the landform contours, soil physical and chemical characteristics match the requirements of species selection provided the most effective measures to provide the best opportunity for vegetation establishment providing a safe, stable, self sustaining ecosystem.	**Landform Construction** Suitably qualified personnel and equipment to manage earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Landform Monitoring** Suitably qualified personnel and equipment to monitor profile and stability. **Vegetation Trialling** Suitable area, availability of vegetation and suitably qualified personnel to conduct and assess the trialling success. **Seeds and or seedlings**. Availability of vegetation for seed collection and or supply of local seed or seedlings. **Vegetation Monitoring** Suitably qualified personnel to conduction vegetation monitoring.	**Performance Measure:** Native and or introduced pastures meeting 60% cover over consecutive years **Constraint:** Long term establishment of vegetation is constrained by water availability over consecutive years.	Determine proportion of organic groundcover, density and diversity of perennial, palatable and productive (3P) pasture species as per Biodiversity Monitoring section of the PRCP Part B. Pasture Productivity Assessment by AQP outlined in Land Capability Monitoring section of the PRCP Part B. Land Capability Monitoring as per Table 3 9 A progressive certification report (or final rehabilitation report as part of the requirements of an application to surrender an environmental authority) will be compiled and submitted to DES	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of vegetation monitoring scheduling is outlined in Section 3.7 of PRCP Part B.
R6	Access to backfilled pit containing excessively steep slopes/drop-offs results in human/fauna injury or death.	• Redesign of final landform has removed the partial backfill of the Northern Pit and it is to be recontoured to blend into the surrounding landform, therefore eliminating the risk. Previously considered treatments to reduce risk below high: • Construction of safety bunds at 2 m high, base width of 5 m from unweathered, freely-draining, end-dumped rockfill at a minimum 20 m offset from the depression perimeter as per the void closure plan. • Backfill to 270RL (water level based on groundwater conceptual modelling).	These treatments were considered the most effective measures to provide a safe, stable so as not to be a health risk.	**Landform Construction** Suitably qualified personnel and equipment to manage earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Landform Monitoring** Suitably qualified personnel and equipment to monitor profile and stability.	**Performance Measure:** Safe, stable self sustaining landform. **Constraint:** The performance measure is constrained by any person traversing the site following directions for signage and barricading.	Monitoring will consist of both visual (field-based assessments) and GIS (remote sensing) technologies (such as LiDAR) to ensure the final landform is safe, stable. Details can be found in Table 3-31 Final Landform Monitoring	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan, the Rehabilitation Management Plan (RMP) and Rehabilitation Monitoring Program

Low Initial Risk		Low Residual Risk
Medium Initial Risk		Medium Residual Risk
High Initial Risk		High Residual Risk

Risk Ref.	Risk Source or Event	Proposed Controls and Treatments*	Reasons for selecting treatment option	Resource Requirements	Performance Measures and Constraints	Monitoring and Reporting	Timing and Scheduling
R7	Significant wet weather event destabilises pit walls and slopes.	• Redesign of final landform has removed the partial backfill of the Northern Pit and it is to be recontoured to blend into the surrounding landform, therefore eliminating the risk. Previously considered treatments to reduce risk below high: • Final landform design developed with ample consideration to material characteristics. • Site wide drainage and flood assessment with implementation of associated recommendations/management measures. • Mine site closure drainage design minimises concentrated stormwater flows. • Landform uses slopes less than 15%, to be re-assessed and designed as per the chemical and physical characteristics of the site. • Void backfilled to 270RL (water level based on groundwater conceptual modelling). • Structural, geotechnical and hydraulic factors determined based on the physical and chemical characteristics of the site.	The redesign to remove PMLU of water storage in the North Pit area eliminated the risk.	Not Applicable	Not Applicable	Not Applicable	Not Applicable
R8	Surface run off, discharge or seepage of hazardous material from mine voids results in an exceedance of receiving environment contaminant limits.	• Redesign of final landform has removed the partial backfill of the Northern Pit and it is to be recontoured to blend into the surrounding landform, therefore eliminating the risk. Previously considered treatments to reduce risk below high: • Removal of all mine affected water. • Contaminated sediments removed. • Installation of certified contours and drains as per design by an AQP (CPESC). • Cover exposed coal seams with 2 or more meters of geochemically benign material. • Problematic waste managed in accordance with dedicated MWMP. • Removal of all mine affected water for use in dust suppression prior to backfilling. • Removal of potential contaminated sediments that may be identified in the land contamination survey.	The redesign to remove PMLU of water storage in the North Pit area eliminated the risk.	Not Applicable	Not Applicable	Not Applicable	Not Applicable
R9	Rehabilitation fails to link with terrestrial vegetation and does not meet the species richness criteria.	• Redesign of final landform has removed the partial backfill of the Northern Pit and it is to be recontoured to blend into the surrounding landform, therefore eliminating the risk. Previously considered treatments to reduce risk below high: • Rehabilitation trials and/or benchmarking assessment if required. Implement the Rehabilitation Management and Monitoring Plans. • Backfill to 270 RL. • Soil assessment prior to use in rehabilitation. • Reshaping, trimming and construction of long-term drainage/ESC. • Establishment of a mix of perennial grasses suitable for grazing in the area.	The redesign to remove PMLU of water storage in the North Pit area eliminated the risk.	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Low Initial Risk	Low Residual Risk
Medium Initial Risk	Medium Residual Risk
High Initial Risk	High Residual Risk

Risk Ref.	Risk Source or Event	Proposed Controls and Treatments*	Reasons for selecting treatment option	Resource Requirements	Performance Measures and Constraints	Monitoring and Reporting	Timing and Scheduling
R10	Central Pit not completely backfilled.	• Ongoing materials characterisation and accounting during operations. • Final landform and associated backfilling design accounts for material characteristics and volumes.	Keeping material management front of mind during operations is the most effective approach to ensuring enough materials are available for the final landform.	**Material Management** required personnel to ensure rigourous material assessment and management in close consultation with earth moving peronnell. **Landform Construction** Suitably qualified personnel and equipment to manage earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Landform Monitoring** Suitably qualified personnel and equipment to monitor profile and stability.	**Performance Measure:** Safe, stable self sustaining landform is achieved which is above the long term groundwater level becomming part of the broader terrestial ecosystem. **Constraint:** The performance measure is constrained by any person traversing the site following directions for signage and barricading.	• Landform compliance audit against design criteria by AQP. • Rehabilitation performance monitoring, including erosion parameters. • Continuation of Receiving Environment Monitoring Program (REMP) and Water Management Plan (WMP) as adapted from operations to post closure.	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan, the Rehabilitation Management Plan (RMP) and Rehabilitation Monitoring Program
R11	Erosion of Central Pit area following significant wet weather event results in increasing landform instability.	• Landform designed, reshaped/re-profiled to minimise and control stormwater and sediment. • Installation of long term erosion and sediment control systems/features. • Hydrological modelling to inform design criteria. • Remediate subsidence and erosion issues before sourcing, delivering, and spreading growth media. • Rejects buried above the expected (post closure) groundwater level, if required. • Backfill associated sediment dams. • Non-erosive materials used to sheet outer surfaces. • Rehabilitation earthworks QA/QC program. • Landform constructed in accordance with design. • Assessment of hydraulic properties of backfilled material conducted by AQP to ascertain potential for instability.	These treatments were considered the most effective measures to minimise the opportunity for erosion following a significant dellugе and maintain a a safe, stable, non-polluting with a self sustaining ecosystem.	**Material Management** Required personnel to ensure rigourous material assessment and management in close consultation with earth moving peronnell. **Landform Construction** Suitably qualified personnel and equipment to manage earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Landform Monitoring** Suitably qualified personnel and equipment to monitor profile and stability.	**Performance Measure:** The following parameters are within acceptable standards following significant wet weather events: • No active areas of rill or gully erosion. • Measurable erosion not exceeding approved erosion rate. • Drainage follows appropriate drainage paths. • No major slumping. • No exposed hazardous materials. **Constraint:** Measurement of this aspect is constrained by the significance of wet weather events following completion of final landform.	Annual survey of rehabilitation area to ensure landform conforms to completion criteria for 5 years. On the 5 year a geotechnical audit will be completed.	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan, the Rehabilitation Management Plan (RMP) and Rehabilitation Monitoring Program.
R12	Poor handling and encapsulation of PAF materials in the Central Pit area results in seepage of contaminated water to groundwater resources.	• Landform designed, reshaped/re-profiled to minimise and control stormwater and sediment. • Installation of long term erosion and sediment control systems/features. • Hydrological modelling to inform design criteria. • Remediate subsidence and erosion issues before sourcing, delivering, and spreading growth media. • Rejects buried above the expected (post closure) groundwater level, if required. • Non-erosive materials used to sheet outer surfaces. • Rehabilitation earthworks QA/QC program. • Landform constructed in accordance with design. • Assessment of hydraulic properties of backfilled material conducted by AQP to ascertain potential for instability.	These treatments were considered the most effective measures to ensure the encapsulation of waste material remains effective in not providing a pathway for leachate to enter the surrounding environment.	**Landform Construction** Suitably qualified personnel and equipment to manage material characterisation, earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Groundwater Monitoring** Material and personnel for installation of a suitable groundwater monitoring network. Suitably qualified personnel and equipment to monitor groundwater quality.	**Performance Measure:** No evidence of unsuitable groundwater quality. **Constraint:** Measurement of this aspect is constrained by the movement of the groundwater and impacts may not be obvious immediately. Finding the source of any contamination may require additional monitoring bores to be installed.	• Monitoring and sampling of groundwater conducted in line with the latest edition of the administering authority's Monitoring and Sampling Manual. • Sampling and testing to ensure water quality limits are not exceeded (including in-situ pH, EC and suspended solids, metals/metalloids and total petroleum hydrocarbons).	The final landforms to restrict impact on the groundwater will be managed through the medium and long-term Mine Plan, Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of the groundwater monitoring scheduling is outlined in Section 3.7 of PRCP Part B.
R13	Surface runoff from backfilled Central Pit area causes exceedance of receiving environment contaminant limits.	• Installation of certified contours and drains as per design by an AQP (CPESC). • Problematic waste managed in accordance with dedicated MWMP. • Landform design encapsulates problematic materials and promotes low energy stormwater runoff.	These treatments were considered the most effective measures to minimise the opportunity for contamination of drainage water following a significant dellugе and maintain a a safe, stable, non-polluting with a self sustaining ecosystem.	Personnel and Equipment available to ensure the Mineral Waste Management Plan (MWMP) is able to be implemented. This will include: Progressive sampling and characterisation of waste material Seepage and leachability testing of material disposal areas	**Performance Measure:** Any water run-off or seepage does not result in sub-standard water quality entering the receiving environment. **Constraint:** Enough capacity in the final landform design to contain all hazardous material.	• Receiving water quality indicators do not exceed specified criteria limits as per BME Receiving Environment Monitoring Program (REMP). • Hydrological survey (i.e., LiDAR). • Drainage and runoff assessments to identify and rectify converging flow paths. • Annual visual survey of rehabilitation area to ensure exposure of hazardous material or evidence of contaminated drainage. • Certification by an AQP that rejects have been managed in accordance with design criteria (survey and QA/QC report audits).	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of water monitoring scheduling is outlined in Section 3.7 of PRCP Part B.

Low Initial Risk		Low Residual Risk	
Medium Initial Risk		Medium Residual Risk	
High Initial Risk		High Residual Risk	

Risk Ref.	Risk Source or Event	Proposed Controls and Treatments*	Reasons for selecting treatment option	Resource Requirements	Performance Measures and Constraints	Monitoring and Reporting	Timing and Scheduling
R14	Vegetation in Central Pit area fails to establish on rehabilitated landform or does not meet the target vegetation criteria.	• Continued waste characterisation and inventory. • Growth medium demonstrated to be appropriate for selected vegetation species (and vice versa). • Rehabilitation trials and/or benchmarking to determine most effective rehabilitation methodology and seed species if required. • Completion criteria are achievable based on assessment of trial data and local benchmarking.	Ensuring the lanform contours, soil physical and chemical characteristics match the requirements of species selection provided the most effective measures to provide the best opportunity for vegetation establishment providing a safe, stable, self sustaining ecosystem.	**Landform Construction** Suitably qualified personnel and equipment to manage earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Landform Monitoring** Suitably qualified personnel and equipment to monitor profile and stability. **Vegetation Trialling** Suitable area, availability of vegetation and suitably qualified personnel to conduct and assess the trialling success. **Seeds and or seedlings**. Availability of vegetation for seed collection and or supply of local seed or seedlings. **Vegetation Monitoring** Suitably qualified personnel to conduction vegetation monitoring.	**Performance Measure:** Native and or introduced pastures meeting 60% cover over consecutive years **Constraint:** Long term establishment of vegetation is constrained by water availability over consecutive years.	Determine proportion of organic groundcover, density and diversity of perennial, palatable and productive (3P) pasture species as per Biodiversity Monitoring section of the PRCP Part B. Pasture Productivity Assessment by AQP outlined in Land Capability Monitoring section of the PRCP Part B. Land Capability Monitoring as per Table 3 9 A progressive certification report (or final rehabilitation report as part of the requirements of an application to surrender an environmental authority) will be compiled and submitted to DES	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of vegetation monitoring scheduling is outlined in Section 3.7 of PRCP Part B.
R15	Access to water storage in the Southern Void results in human or fauna injury or death.	• Safety bund constructed at 2 m high, with a base width of 5 m from unweathered, freely-draining, end dumped rockfill at a minimum 20 m offset from the pit zone of instability as per the closure plan. • Fence entire perimeter and bund to high wall areas. • No public access to high wall or end wall areas. • Minimise void area. • Stabilise walls and slopes as per the void closure plan. • Design and construct the void as per the void closure plan. • Partial backfill according to the groundwater level and as per the baseline groundwater assessment. • Drainage promotes runoff into the void. • Backfill above the groundwater level (water level based on conceptual modelling).	These treatments were considered the most effective measures to provide a safe, stable so as not to be a health risk.	**Material Management** Required personnel to ensure rigourous material assessment and management for design of the water storage area that work in closely consultation with earth moving peronnell. **Landform Construction** Suitably qualified personnel and equipment to manage earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Landform Monitoring** Suitably qualified personnel and equipment to monitor profile and stability.	**Performance Measure:** Safe, stable self sustaining landform that limits accidental access to the water storage area. **Constraint:** The performance measure is constrained by any person traversing the site following directions for signage and barricading.	Monitoring will consist of both visual (field-based assessments) and GIS (remote sensing) technologies (such as LiDAR) to ensure the final landform is safe, stable. On-ground assessment of the access to the water storage area once all controls are in place. Details can be found in Table 3-31 Final Landform Monitoring	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan, the Rehabilitation Management Plan (RMP) and Rehabilitation Monitoring Program
R16	Uncontained Southern Void waters impact surface or groundwater and exceed receiving environment contaminant limits.	• Final void located outside of the Isaac River floodplain, as defined under the EP Act. • Pit wall geochemical characterisation. • Development of a robust hydrogeological model. • Long term pit lake water modelling (geochemical and water balance). • Coal seams to be treated, removed or covered in the backfilling process. • Installation of certified contours and drains as per design by an AQP (CPESC). • Conduct a water balance study to assess the void surface and groundwater interactions. • Conduct effective measures to avoid generation or release of saline drainage and acid rock drainage.	These treatments were considered the most effective measures to minimise the opportunity for loss of contamination of void waste following a significant deluge and not impacting the surround environment.	**Landform Construction** Suitably qualified personnel and equipment to manage material characterisation, earth moving and dust management equipment to contour the landform to contain water during high overland water flow events. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Groundwater Monitoring** Material and personnel for installation of a suitable groundwater monitoring network. Suitably qualified personnel and equipment to monitor groundwater quality.	**Performance Measure:** Water contained within the void to avoid water from the water storage area entering the receiving environment. **Constraint:** Higher than expected flooding of the general area.	• Water level monitoring and receiving water quality indicators do not indicate water being received from the water storage area in the receiving environment. • Water quality does not exceed specified criteria limits as per BME Receiving Environment Monitoring Program (REMP). • Hydrological survey (i.e., LiDAR). • Drainage and runoff assessments to identify and rectify converging flow paths. • Annual visual survey of rehabilitation area to ensure exposure of hazardous material or evidence of contaminated drainage. • Certification by an AQP that rejects have been managed in accordance with design criteria (survey and QA/QC report audits).	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of water monitoring scheduling is outlined in Section 3.7 of PRCP Part B.

Low Initial Risk	Low Residual Risk
Medium Initial Risk	Medium Residual Risk
High Initial Risk	High Residual Risk

Risk Ref.	Risk Source or Event	Proposed Controls and Treatments*	Reasons for selecting treatment option	Resource Requirements	Performance Measures and Constraints	Monitoring and Reporting	Timing and Scheduling
R17	Erosion from the water strage ares following significant wet weather events results in increasing landform instability.	• Landform design uses non-erosive materials on the outer surfaces. • Landform constructed in accordance with QA/QC plan (survey). • Final shape implemented as per rehabilitation and management strategies included in the void closure plan. • Structural, geotechnical and hydraulic factors based on the physical and chemical characteristics of the site. • Long term erosion and sediment control systems/features installed as per closure ESCP based on achieved groundcover and landform stability • Structural, geotechnical and hydraulic factors determined based on the physical and chemical characteristics of the site. • Drainage measures and structures have been appropriately established and are directing overland flow away from the highwall edge	These treatments were considered the most effective measures to minimise the opportunity for erosion following a significant deluge and maintain a safe, stable, non-polluting with a self sustaining ecosystem.	**Material Management** Required personnel to ensure rigorous material assessment and management in close consultation with earth moving personnel. **Landform Construction** Suitably qualified personnel and equipment to manage earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Landform Monitoring** Suitably qualified personnel and equipment to monitor profile and stability.	**Performance Measure:** The following parameters are within acceptable standards following significant wet weather events: • No active areas of rill or gully erosion. • Measurable erosion not exceeding approved erosion rate. • Drainage follows appropriate drainage paths. • No major slumping. • No exposed hazardous materials. **Constraint:** Measurement of this aspect is constrained by the significance of wet weather events following completion of final landform.	Annual survey of rehabilitation area to ensure landform conforms to completion criteria for 5 years. On the 5 year a geotechnical audit will be completed.	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan, the Rehabilitation Management Plan (RMP) and Rehabilitation Monitoring Program.
R18	The soutern void long term water quality target is not achieved resulting in a final landform that does maintain its PMLU.	• Design final slope angles of the high, low and end walls. • Implement designs and recommendations from the final void design plan. • Manage long term water quality for livestock consumption. • Backfill to above the regional groundwater level. • Treat or remove exposed coal seams. • Develop specific rehabilitation strategies that includes monitoring, surveying, stability analysis and reporting. • Surface water quality of the receiving environment as per water management plan	These treatments were considered the most effective measures to provide the expected standard of livestock drinking water.	**Material Management** Required personnel to ensure rigorous material assessment and management for design of the water storage area that work in closely consultation with earth moving personnel. **Landform Construction** Suitably qualified personnel and equipment to manage material characterisation, earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Water Monitoring** Material and personnel for installation of a suitable surface monitoring locations that can be accessed at multiple water levels. Suitably qualified personnel and equipment to monitor water quality.	**Performance Measure:** Water quality remains within expected parameters. **Constraint:** Measurement of this aspect is constrained by the movement of the groundwater and surface water into the void and impacts may not be obvious immediately. Finding the source of any contamination identified may require additional monitoring.	• Monitoring and sampling of water conducted in line with the latest edition of the administering authority's Monitoring and Sampling Manual. • Sampling and testing to ensure water quality limits are within expected parameters.	The final landforms to restrict impact on the groundwater will be managed through the medium and long-term Mine Plan, Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of the water monitoring scheduling is outlined in Section 3.7 of PRCP Part B.
R19	Associated infrastructure is not adequately decommissioned and rehabilitated.	• Remove all associated infrastructure, including fencing and signage. • General reshaping and pushing/trimming to achieve final landform design.	These treatments were considered the most effective measures to provide a safe, stable and non-polluting..	**Infrastructure Removal** Personnel and equipment required to remove and dispose of infrastructure. **Landform Construction** Suitably qualified personnel and equipment to manage material characterisation, earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Water Monitoring** Material and personnel for installation of a suitable surface monitoring locations that can be accessed at multiple water levels. Suitably qualified personnel and equipment to monitor water quality.	**Performance Measure:** Infrastructure removed and area free of rubbish and contaminated soil. Sild ripped and landform returned to a safe and stable condition. **Constraint:** Hidden contamination may be exposed during infrastructure removed which may require on-site remediation of soil or off-site disposal.	• Site inspection to ensure there is: • No remaining infrastructure other than that agreed with the landowner, • There is no evidence of contamination • There soil is returned to a condition that is consistent with the PMLU.	The final landforms to restrict impact on the groundwater will be managed through the medium and long-term Mine Plan, Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program.

Low Initial Risk	Low Residual Risk
Medium Initial Risk	Medium Residual Risk
High Initial Risk	High Residual Risk

Risk Ref.	Risk Source or Event	Proposed Controls and Treatments*	Reasons for selecting treatment option	Resource Requirements	Performance Measures and Constraints	Monitoring and Reporting	Timing and Scheduling
R20	Erosion following significant wet weather events results in increasing landform instability in operational water storage areas.	• Dewater (for use in dust suppression) prior to rehab if applicable. • Installation of certified contours and drains as per design by an AQP (CPESC). • Final landform and associated backfilling design accounts for material characteristics and volumes.	These treatments were considered the most effective measures to provide a safe, stable, non-polluting with a self sustaining ecosystem.	**Material Management** Required personnel to ensure rigorous material assessment and management for design of the water storage area that work in closely consultation with earth moving personnel. **Landform Construction** Suitably qualified personnel and equipment to manage material characterisation, earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment.	**Performance Measure:** The following parameters are within acceptable standards following significant wet weather events: • No active areas of rill or gully erosion. • Measurable erosion not exceeding approved erosion rate. • Drainage follows appropriate drainage paths. • No major slumping. • No exposed hazardous materials. **Constraint:** Measurement of this aspect is constrained by the significance of wet weather events following completion of final landform.	Annual survey of rehabilitation area to ensure landform conforms to completion criteria for 5 years. On the 5 year a geotechnical audit will be completed.	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan, the Rehabilitation Management Plan (RMP) and Rehabilitation Monitoring Program.
R21	Surface runoff and/or discharge or seepage of hazardous material from rehabilitated water storage infrastructure results in an exceedance of receiving environment contaminant limits.	Remove all potentially hazardous water/sediment from the facility prior to rehabilitation works.	These treatments were considered the most effective measures to minimise the opportunity for contamination of drainage water following a significant deluge and maintain a safe, stable, non-polluting with a self sustaining ecosystem.	Personnel and Equipment available to ensure the Mineral Waste Management Plan (MWMP) is able to be implemented. This will include: Progressive sampling and characterisation of waste material Seepage and leachability testing of material disposal areas	**Performance Measure:** Any water run-off or seepage does not result in sub-standard water quality entering the receiving environment. **Constraint:** Enough capacity in the final landform design to contain all hazardous material.	• Receiving water quality indicators do not exceed specified criteria limits as per BME Receiving Environment Monitoring Program (REMP). • Hydrological survey (i.e., LiDAR). • Drainage and runoff assessments to identify and rectify converging flow paths. • Annual visual survey of rehabilitation area to ensure exposure of hazardous material or evidence of contaminated drainage. • Certification by an AQP that rejects have been managed in accordance with design criteria (survey and QA/QC report audits).	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of water monitoring scheduling is outlined in Section 3.7 of PRCP Part B.
R22	Rehabilitation does not meet the target vegetation criteria in previous water storage areas.	• Conduct land contamination investigation. • Remove sediment or bury insitu.	Ensuring the landform contours, soil physical and chemical characteristics match the requirements of species selection provided the most effective measures to provide the best opportunity for vegetation establishment providing a safe, stable, self sustaining ecosystem.	**Landform Construction** Suitably qualified personnel and equipment to manage earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Landform Monitoring** Suitably qualified personnel and equipment to monitor profile and stability. **Vegetation Trialling** Suitable area, availability of vegetation and suitably qualified personnel to conduct and assess the trialling success. **Seeds and or seedlings**. Availability of vegetation for seed collection and or supply of local seed or seedlings. **Vegetation Monitoring** Suitably qualified personnel to conduction vegetation monitoring.	**Performance Measure:** Native and or introduced pastures meeting 60% cover over consecutive years **Constraint:** Long term establishment of vegetation is constrained by water availability over consecutive years.	Determine proportion of organic groundcover, density and diversity of perennial, palatable and productive (3P) pasture species as per Biodiversity Monitoring section of the PRCP Part B. Pasture Productivity Assessment by AQP outlined in Land Capability Monitoring section of the PRCP Part B. Land Capability Monitoring as per Table 3-9 A progressive certification report (or final rehabilitation report as part of the requirements of an application to surrender an environmental authority) will be compiled and submitted to DES	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of vegetation monitoring scheduling is outlined in Section 3.7 of PRCP Part B.
R23	Access to landform containing unrehabilitated drill holes results in human injury or fauna death.	• Surface preparation in line with surrounding topography. • Rehabilitate all exploration drill holes in accordance with the applicable Australian Standard or guideline. • Progressive rehabilitation. • Drill holes grouted and casings cut to ground level.	These treatments were considered the most effective measures to provide a safe, stable, non-polluting with a self sustaining ecosystem.	Personnel and equipment necessary to make drill holes safe and stable consistent with surrounding landform.	Site survey to inspect all areas where drill holes are expected: • Landform is profiled in line with surrounding topography. • Progressive rehabilitation certification under the EP Act. • Drill holes rehabilitated in line with 'Requirements for Water Bores in Australia' (Australian Government, February 2012) or latest edition. • No active areas of rill or gully erosion and drainage follows the appropriate drainage paths.	• Landform is profiled in line with surrounding topography. • Progressive rehabilitation certification under the EP Act. • Drill holes rehabilitated in line with 'Requirements for Water Bores in Australia' (Australian Government, February 2012) or latest edition. • No active areas of rill or gully erosion and drainage follows the appropriate drainage paths.	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan, the Rehabilitation Management Plan (RMP) and Rehabilitation Monitoring Program.

Low Initial Risk	Low Residual Risk
Medium Initial Risk	Medium Residual Risk
High Initial Risk	High Residual Risk

Risk Ref.	Risk Source or Event	Proposed Controls and Treatments*	Reasons for selecting treatment option	Resource Requirements	Performance Measures and Constraints	Monitoring and Reporting	Timing and Scheduling
R24	Surface run off, discharge or seepage of hazardous material from infrastructure areas results in an exceedance of receiving environment contaminant limits.	• Conduct land contamination investigation. • Remove buildings. • Remove and proper disposal of road surface and fencing. • Disconnect services, empty tanks, and licenced removal of contaminated water. • Remove and properly dispose of general and regulated waste. • Remove imported fill used to raise MIA (treat as contaminated) and encapsulate in backfilled pit or open waste dumps. • Contaminated soil identified and removed in accordance with relevant guidelines and standards.	These treatments were considered the most effective measures to minimise the opportunity for contamination of water from remaining hazardous material.	Personnel and Equipment available to ensure the Mineral Waste Management Plan (MWMP) is able to be implemented. This will include: Progressive sampling and characterisation of waste material Seepage and leachability testing of material disposal areas	**Performance Measure:** Any water run-off or seepage does not result in sub-standard water quality entering the receiving environment. **Constraint:** Unknown contamination until infrastructure is removed	• Receiving water quality indicators do not exceed specified criteria limits as per BME Receiving Environment Monitoring Program (REMP). • Hydrological survey (i.e., LiDAR). • Drainage and runoff assessments to identify and rectify converging flow paths. • Annual visual survey of rehabilitation area to ensure exposure of hazardous material or evidence of contaminated drainage. • Certification by an AQP that rejects have been managed in accordance with design criteria (survey and QA/QC report audits).	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of water monitoring scheduling is outlined in Section 3.7 of PRCP Part B.
R25	Rehabilitation does not meet the target vegetation criteria in previous infrastructre areas	• All disturbance areas will be contour ripped to break up compaction. • Seeding and ameroation if required from any soil sampling program. • Monitoring and reporting.	Ensuring the landform contours, soil physical and chemical characteristics match the requirements of species selection provided the most effective measures to provide the best opportunity for vegetation establishment providing a safe, stable, self sustaining ecosystem.	**Landform Construction** Suitably qualified personnel and equipment to manage earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Landform Monitoring** Suitably qualified personnel and equipment to monitor profile and stability. **Vegetation Trialling** Suitable area, availability of vegetation and suitably qualified personnel to conduct and assess the trialling success. **Seeds and or seedlings**. Availability of vegetation for seed collection and or supply of local seed or seedlings. **Vegetation Monitoring** Suitably qualified personnel to conduction vegetation monitoring.	**Performance Measure:** Native and or introduced pastures meeting 60% cover over consecutive years **Constraint:** Long term establishment of vegetation is constrained by water availability over consecutive years.	Determine proportion of organic groundcover, density and diversity of perennial, palatable and productive (3P) pasture species as per Biodiversity Monitoring section of the PRCP Part B. Pasture Productivity Assessment by AQP outlined in Land Capability Monitoring section of the PRCP Part B. Land Capability Monitoring as per Table 3 9 A progressive certification report (or final rehabilitation report as part of the requirements of an application to surrender an environmental authority) will be compiled and submitted to DES	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of vegetation monitoring scheduling is outlined in Section 3.7 of PRCP Part B.
R26	Residual roads, tracks, signage or fencing remain post decommissioning.	• Surface preparation. • Installation of long term erosion and sediment control systems where required. • Source, cart and spread growth media. • Rip and seed. • Decommissioning undertaken by a suitably qualified contractor and managed by an experienced mine site demolition and decommissioning contractor. • Maintain a detailed decommissioning cost estimate as part of ongoing closure liability cost estimates.	These treatments were considered the most effective measures to provide a safe, stable and non-polluting..	**Infrastructure Removal** Personnel and equipment required to remove and dispose of infrastructure. **Landform Construction** Suitably qualified personnel and equipment to manage material characterisation, earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Water Monitoring** Material and personnel for installation of a suitable surface monitoring locations that can be accessed at multiple water levels. Suitably qualified personnel and equipment to monitor water quality.	• No residual infrastructure upon completion of decommissioning activities. • Landform is profiled in line with surrounding topography. • No active areas of rill or gully erosion and drainage follows the appropriate drainage paths.	• Site inspection to ensure there is: • No remaining infrastructure other than that agreed with the landowner, • There is no evidence of contamination • There soil is returned to a condition that is consistent with the PMLU.	The final landforms to restrict impact on the groundwater will be managed through the medium and long-term Mine Plan, Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program.

Low Initial Risk	Low Residual Risk
Medium Initial Risk	Medium Residual Risk
High Initial Risk	High Residual Risk

Risk Ref.	Risk Source or Event	Proposed Controls and Treatments*	Reasons for selecting treatment option	Resource Requirements	Performance Measures and Constraints	Monitoring and Reporting	Timing and Scheduling
R27	Surface water run from areas where there was roads and tracks off results in an exceedance of receiving environment contaminant limits.	• AQP to conduct land contamination investigation. • Contaminated soil identified and removed in accordance with relevant guidelines and standards.	These treatments were considered the most effective measures to minimise the opportunity for contamination of water from remaining hazardous material.	Personnel and Equipment available to ensure the Mineral Waste Management Plan (MWMP) is able to be implemented. This will include: Progressive sampling and characterisation of waste material Seepage and leachability testing of material disposal areas	**Performance Measure:** Any water run-off or seepage does not result in sub-standard water quality entering the receiving environment. **Constraint:** Unknown contamination until infrastructure is removed	• Receiving water quality indicators do not exceed specified criteria limits as per BME Receiving Environment Monitoring Program (REMP). • Hydrological survey (i.e., LiDAR). • Drainage and runoff assessments to identify and rectify converging flow paths. • Annual visual survey of rehabilitation area to ensure exposure of hazardous material or evidence of contaminated drainage. • Certification by an AQP that rejects have been managed in accordance with design criteria (survey and QA/QC report audits).	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of water monitoring scheduling is outlined in Section 3.7 of PRCP Part B.
R28	Soils where there were roads and track remain heavily compacted.	• Progressive rehabilitation • General reshaping and pushing trimming to achieve pre-disturbance contours (including re-establishment of bed and banks). • Installation of long terms erosion and sediment control systems where required. • Source, cart and spread growth media. • Rip and seed. • Monitoring and reporting.	These treatments were considered the most effective measures to provide a safe, stable, non-polluting with a self sustaining ecosystem.	**Infrastructure Removal** Personnel and equipment required to remove and dispose of infrastructure. **Landform Construction** Suitably qualified personnel and equipment to manage material characterisation, earth moving and dust management equipment. **Landform Stabilisation** Suitably qualified personnel and equipment to manage deep ripping, seeding, fertilisation, mulching, watering and monitoring equipment. **Water Monitoring** Material and personnel for installation of a suitable surface monitoring locations that can be accessed at multiple water levels. Suitably qualified personnel and equipment to monitor water quality.	**Performance Measure:** Native and or introduced pastures meeting 60% cover over consecutive years **Constraint:** Long term establishment of vegetation is constrained by water availability over consecutive years.	Determine proportion of organic groundcover, density and diversity of perennial, palatable and productive (3P) pasture species as per Biodiversity Monitoring section of the PRCP Part B. Pasture Productivity Assessment by AQP outlined in Land Capability Monitoring section of the PRCP Part B. Land Capability Monitoring as per Table 3 9 A progressive certification report (or final rehabilitation report as part of the requirements of an application to surrender an environmental authority) will be compiled and submitted to DES	The final landform will be managed through the medium and long-term Mine Plan, Topsoil Management Plan (TMP), the Material Waste Management Plan (MWMP), Residual Void (Southern Void) Design and Closure Plan and the Rehabilitation Management Plan (RMP) and the Rehabilitation Monitoring Program. Details of vegetation monitoring scheduling is outlined in Section 3.7 of PRCP Part B.

* The controls and treatments will be reflected in the broader site management plans with individual responsibilities assigned within these plans. The overall responsibility to ensure this risk remains at its residual risk classification rests with the Chief Operating Officer.