Permit

Environmental Protection Act 1994

Environmental authority EA0002465 Broadmeadow East Mine

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 6 December 2024

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

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority (EA) is issued is a restatement of the ERA as defined by legislation at the time the EA is issued. Where there is any inconsistency

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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 land give written notice to the administering authority if they become aware of the following:

- the presence of, or happening of an event involving, a hazardous contaminant on the land that is causing, or is reasonably likely to cause, serious or material environmental harm (notice must be given within 24 hours); or
- if the land is contaminated land – a change in the condition of the land that is causing, or is reasonably likely to cause, serious or material environmental harm (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 land (notice must be given within 20 business days).

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

Take effect

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

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

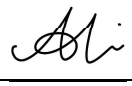
b) if the authority states a day or an event for it to take effect – on the stated day or when the stated event happens; or

c) otherwise – on the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *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.

	6 December 2024
Signature	Date

Dr Alison Cummings
Department of the Environment, Tourism, Science and Innovation
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Business Centre Coal
Department of the Environment, Science and Innovation
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 Resources (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.resources.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, Science and Innovation 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
Definitions	
Figures	Figure 1a – Disturbance Map Figure 1b – Indicative Mine Domain Plan Figure 2 – Mine affected water release points and monitoring locations Figure 3 – Final landform, post closure Figure 4 – Final landform design aspects for the Southern Void
Appendix 1	Appendix 1: Table G1 – Post Mine Land Use (PMLU) and Non-Use Management Area (NUMA) Rehabilitation Methods Table G2 – PMLU and NUMA Rehabilitation Success Criteria

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 1a - Disturbance Map** b) is not authorised in the areas marked 'B' as depicted in **Figure 1a - Disturbance Map**; and c) is only authorised in the areas marked 'C' as depicted in **Figure 1a - 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 1a - 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	**Complaints** 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 environmental harm or an exceedance of the limits in **Table B1 - Ambient Air Quality Limits and Monitoring Methods** at a sensitive or commercial place. The measurement of air emissions for a sensitive place or commercial place is either: a) at that place (if measured there); or b) at the monitoring location representative (whether by reason of correlation or otherwise) of the sensitive place or commercial place (where there is no measure at the sensitive place or commercial place).
B2	Dust and particulate matter emissions and meteorological conditions must be monitored in accordance with **Table B1 - Ambient Air Quality Limits and Monitoring Methods**
B3	**Air Quality Monitoring and Management Plan** An Air Quality Monitoring and Management Plan must be developed and implemented for the duration 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	**Air quality monitoring exceedance** If the monitoring indicates an exceedance of the relevant limits in **Table B1 - Ambient Air Quality Limits and Monitoring Methods** at any sensitive place or commercial place, the environmental authority holder must report to the administering authority within **ten (10)** business days or a longer time period as agreed to by the administrating authority: a) the air quality data at the sensitive place or commercial place; b) a description of meteorological conditions recorded in accordance with **Table B1 - Ambient Air Quality Limits and Monitoring Methods** occurring at the time; c) the air quality data upwind of the mining activities (if known); d) measures taken to reduce dust generated by the mining activities; and e) the contribution of the mining activities to the PM10 and/or dust deposition concentration at the sensitive or commercial place.

Table B1 – Ambient Air Quality Limits and Monitoring Methods

Air Quality Determination/ Indicator	Air quality limit	Averaging period	Monitoring standard
Particulate matter less than 10µm in aerodynamic diameter (PM_{10})	50µg/m^3	24-hour	AS3580.9.11 *Determination of suspended particulate matter — PM10 beta attenuation monitors.*
Dust deposition	120 mg/m^2/day	Monthly	AS3580.10.*1 Methods for sampling and analysis of ambient air—Determination of particulate matter — Deposited matter –Gravimetric method*.
Meteorological data (including but not limited to wind speed and direction, relative humidity, temperature, precipitation and rainfall intensity, solar radiation)	N/A	Continuous	1. Monitoring by automatic meteorological station(s); 2. Australian Standard *AS3580.14 Methods for sampling and analysis of ambient air – Meteorological monitoring for ambient air quality monitoring locations*; or 3. An alternative method accepted by the administering authority.
Siting of monitoring equipment	N/A	N/A	Determined by an appropriately qualified person

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 2 – 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*	
Total Recoverable hydrocarbons (TRH) (C6-C9)	20 (µg/L)	*For aquatic ecosystem protection, based on LOR for GCMS*	
TRH (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: 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 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**.
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**.

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

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 (unit)	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 to Table C6: *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	**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 2 – Mine affected water release points and monitoring locations** of this authority. NOTE: ***Figure 2 – Mine affected water release points and monitoring locations also shows location of groundwater monitoring bores***.
D3	Groundwater quality monitoring required by **Condition D2**, 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.
D4	**Groundwater drawdown** Monitoring results from groundwater bores identified in **Table D1 – Groundwater monitoring locations and frequencies** must not exceed any of groundwater drawdown trigger levels stated in **Table D1 – Groundwater monitoring locations and frequencies**.
D5	**Exceedance investigation – groundwater drawdown** For groundwater level monitoring as per **Condition D2**, a groundwater drawdown fluctuation above the magnitude identified in **Table D1 - Groundwater level monitoring locations and frequency** for individual monitoring bores must: a) be notified to the administering authority via WaTERS within **one (1) business day of receiving the results**; b) complete an investigation into the cause of the exceedance within **ten (10) business days;** c) if the investigation carried out under part b) determines that the mining activities are a potential cause or contributor to the exceedance: i. notify the administering authority via WaTERS within **24 hours** of making the determination; and ii. within **10 business days** notify the administering authority of the actions taken to ensure compliance with **condition D4** of this environmental authority.

D6	**Groundwater quality** 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 – groundwater quality** 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 **Condition 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, Teviot 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 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 D6**
D15	**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.
D16	**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.
D17	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**.
D18	**Review of groundwater drawdown and quality trigger levels** By **30 October 2026**, the holder of this environmental authority must submit a report to the administering authority that: a) reviews the groundwater drawdown trigger level elevations in **Table D1 – Groundwater monitoring locations and frequencies** using all available groundwater monitoring data collected under condition **D2;** **b)** proposes groundwater trigger level elevations that reflect the maximum modelled drawdown resulting from activities authorised under this environmental authority; c) reviews the groundwater quality triggers in **Table D2 – Groundwater quality limits** using all available groundwater quality monitoring data collected under condition **D2;** and d) were relevant, proposes updated bore specific groundwater quality triggers for inclusion in **Table D2 – Groundwater quality limits.**
D19	**Scheduled Replacement of Bores** If any groundwater monitoring bore listed in **Table D1 – Groundwater monitoring locations and frequency,** are scheduled to be decommissioned due to planned authorised activities, the holder must: a) replace the bore (s) at least twenty-four **(24) months or minimum of 8 monitoring events** prior to decommissioning; with groundwater monitoring bores that targets the same hydrogeological unit in a suitable location; and b) the location of replacement bores be provided for inclusion in **Table D1 – Groundwater monitoring locations and frequency**.

D20	Within twenty-four (24) months or as agreed to by the administrating authority after installation of replacement bores as per condition **D19**, the environmental authority holder must submit report to administering authority that includes: (a) groundwater quality triggers based on at least eight (8) monitoring events for inclusion in **Table D2 – Groundwater quality triggers**; and b) groundwater level threshold for inclusion in **Table D1 – Groundwater monitoring locations and frequency.**

Table D1- Groundwater monitoring locations and frequencies

Monitoring	Easting	Northing	Screened interval (mbgL*)	Aquifer / Monitored Interval	TOC[2] elevation	Pre-mining baseline standing water level elevation (mAHD)	Groundwater trigger level elevation (mAHD)	Monitoring frequency	Comments
MBBE0002[1]	618436	7585329	10.0 to 13.0	Tertiary Sediments	323.7	311.1	N.A	Quarterly	Ongoing
MBBE0003[1]	618431	7584664	4.0 to 7.0	Basalt	345.7	N.A	N.A		Ongoing
MBBE0004[1]	620205	7586976	2.0 to 5.0	Alluvium	290.8	N.A	N.A		Ongoing
MBBE0011[4]	619058	7587386	3.0 to 6.0	Alluvium	285.1	N.A	N.A		Monitoring started Oct 2023
MBBE0005[1]	620519	7586210	4.0 to 7.0	Rewan Group	297.1	N.A	N.A	Not sampled	Ongoing
MBBE0001[5]	619884	7585428	63.0 to 66.0	Rangal Coal Measures	305.2	288.1	241.0	Quarterly	Ongoing until mined through
MBBE0007	620615	7586415	40.0 to 46.0	Rewan Group	297.9	279.6	266.5		Ongoing
MBBE0008	620294	7585092	130.0 to 133.0	Rangal Coal Measures	305.2	285.6	248.7		Ongoing
MBBE0009[4]	620376	7586716	104.0 to 110	Rangal Coal Measures	292.5	267.7	261.1[6]		Monitoring started Oct 2023

MBBE0010[4]	620362	7586723	52.0 to 58.0	Rewan Group	292.4	271.0	267.2		Monitoring started Oct 2023
MBBE0012[4]	619797	7584702	51.0 to 57.0	Rangal Coal Measures	336.4	290.0	280.2		Monitoring started Oct 2023

Notes:
[1] Some bores are often dry and unsuitable as groundwater trigger level elevation bores. MBBEE0002 bore – given the shallow depth of in this bore and potential to go dry no groundwater trigger level elevation has been set.
[2] TOC – top of casing
[3] mAHD – meters Australian Height Datum
[4] Replacement monitoring bores (drilled October 2023)
[5] MBBE0001 to be replaced by MBBE0009. Continue monitoring of both until MBBE0001 is mined out
[6] MBBE0009 interim groundwater trigger level elevation value. To be reviewed and updated as per **Condition D18**.
N.A – not applicable

Table D2 – Groundwater quality limits

Parameter	Unit	MBBE0007	MBBE0001	MBBE0009	MBBE0004	MBBE0011	MBBE0002	MBBE0003	MBBE0010	MBBE0008	MBBE0012
Bore type		Compliance			Reference bores*						
Stratigraphy					Alluvium		Tertiary sediments	Basalt	Rewan Group	Rangal Coal measures	
pH	pH units	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5	Interpretation only						
EC	(µS/cm)	48600	901.7	16000							
Sulfate (SO_4)	(mg/L)	961.5	398	398							
Arsenic	(µg/L)	13	13	13							
Aluminium	(µg/L)	55	80	55							
Mercury	(µg/L)	0.06	0.06	0.06							
Molybdenum	(µg/L)	26.4	34	34							
Selenium	(µg/L)	5	5	5							
TRH (C6-C9)	(µg/L)	<20	<20	<20							
TRH (C10-C40)	(µg/L)	<100	<100	<100							
Cadmium, Lead, Nickel, Chromium, Copper and Zinc	(µg/L)	Interpretation only									
Major ions	(mg/L)	Interpretation only									

Notes:

Bore specific 95th percentile (outliers removed where bore sample data >8)

ANZG (2000) 95% aquatic ecosystem species protection value for slightly to moderately disturbed ecosystem.

To account for the bioaccumulating nature of this toxicant, it is recommended that 99% species protection level Default Guideline Value is used for slightly to moderate disturbed systems.

Default Water Quality Objective (WQO) value – zone 34, >30m deep, 80th percentile (Isaac River Sub-basin Environmental Values and WQO).

Typical Limit of Reporting (LOR) for GC-MS - analytical method

**All reference bores currently monitored for interpretation intent. As per condition D18, triggers will be proposed when sufficient data is available.*

All metals must be measured as total (unfiltered) and dissolved (filtered). The quality limits are based on dissolved concentrations.

TRH- Total Recoverable Hydrocarbon

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	**Noise and Vibration Management Plan** 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** The following must be recorded when undertaking monitoring of noise emissions from the activity: a) All equipment in operation at the time of the noise measurement; and b) The mode of operation at the time of the noise measurement.
E4	All monitoring of noise emissions from the activity must be conducted in accordance with the administering authority's *Noise Measurement Manual* (ESR/2016/2195), the relevant Australian Standard and the Environmental Protection Regulation 2019 (Chapter 5, Part 4).
E5	All recordings during noise monitoring 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; and g) if a 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.
E6	**Noise complaints** When requested by the administering authority or as a result of a complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer), noise monitoring must be undertaken, and the results thereof notified to the administering authority within **14 days** following completion of monitoring. Monitoring must be carried out at a place or places relevant to the potentially affected noise sensitive place as agreed upon with the administering authority.
E7	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.
E8	**Vibration nuisance** Subject to **Conditions A12** and **E9** of this environmental authority vibration from the mining activity must not cause an environmental nuisance, at any sensitive receptor.
E9	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 A12** 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.
E10	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.
E11	For the purposes of **Condition E8** 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**.
E12	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.

E13	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**.
E14	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 wastes 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 and disposal of tyres** Scrap tyres must be stored and disposed of in accordance with the latest version of the Operational policy - *Disposal and storage of scrap tyres at mine sites* (ESR/2016/2380).
F12	**Rejects disposal** Rejects are authorised to be disposed of within spoil emplacements in the following disturbance areas: a) out of pit overburden dumps; and b) central in-pit spoil dump.
F13	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 regular review of the environmental performance and continual improvement 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 1, Table G1 – Post Ming Land Use (PMLU) and Non-Use Management Area (NUMA) Rehabilitation Methods**; b) **Appendix 1, Table G2 – PMLU and NUMA Rehabilitation Success Criteria;**

	c) The Rehabilitation Management Plan required by **Condition G8**.
G6	**Residual Void Outcome** Only the residual void detailed in **Appendix 1**, **Table G1 – Post Mine Land Use (PMLU) and Non-Use Management Area (NUMA) Rehabilitation Methods**, is permitted at the approved place located as per **Figure 1b – Indicative Mine Domain Plan**, **Figure 3 - Final Landform, post closure** and **Figure 4 - Final landform design aspects for the southern void.**
G7	The south residual void as detailed in **Appendix 1**, **Table G1 – Post Mine Land Use (PMLU) and Non-Use Management Area (NUMA) Rehabilitation Methods** must: a) act as groundwater sink to the receiving groundwater environment; and b) at the completion of decommissioning and rehabilitation be protected from Probable Maximum Floods (PMFs) from nearby watercourses such that the protection is sustainable for the foreseeable future.
G8	**Rehabilitation Management Plan** A Rehabilitation Management Plan for all areas disturbed by the authorised mining activities was submitted on **29 September 2023** 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 1, Table G1 – Post Mine Land Use (PMLU) and Non-Use Management Area (NUMA) 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 1, Table G1 – Post Mine Land Use (PMLU) and Non-Use Management Area (NUMA) 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.
G9	Rehabilitation must commence and be undertaken progressively in accordance with the Rehabilitation Management Plan required by **Condition G8**.
G10	**Rehabilitation Monitoring Program** A Rehabilitation Monitoring Program must be developed and implemented by an appropriately qualified person for the life of this environmental authority.
G11	A review of the Rehabilitation Monitoring Program required by **Condition G10** must occur at intervals no greater than **thirty-six (36) months** from the commencement of the mining activities.
G12	A report of the findings of the rehabilitation monitoring program review required by **Condition G11**. The report must contain the following: a) how the rehabilitation objectives in the Rehabilitation Management Plan required by **Condition G8** 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 G8**; e) the sampling and monitoring intensity used in the Rehabilitation Monitoring Program required by **Condition G10**; and f) justification of the sampling and monitoring intensity used in the Rehabilitation Monitoring Program required by **Condition G10**.
G13	**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.*
G14	**Overburden characterisation** The characteristics of overburden must be determined prior to disturbance by mining to a standard sufficient to enable selective handling of materials required.
G15	**Cleared vegetation** 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.
G16	**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.
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.

[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.*

	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; and 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**; b) a set of 'as constructed' drawings and specifications; c) certification of those 'as constructed drawings and specifications' in accordance with **Condition H9**; 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 H27**; 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; and 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.

END OF CONDITIONS

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, Tourism, Science and Innovation 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.

"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).

"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.

"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.*

"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.

"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.

"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.

"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 of 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.

"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 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.

"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.

"**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.

"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.

Figure 1a – Disturbance Map



Figure 1b – Indicative Mine Domain Plan

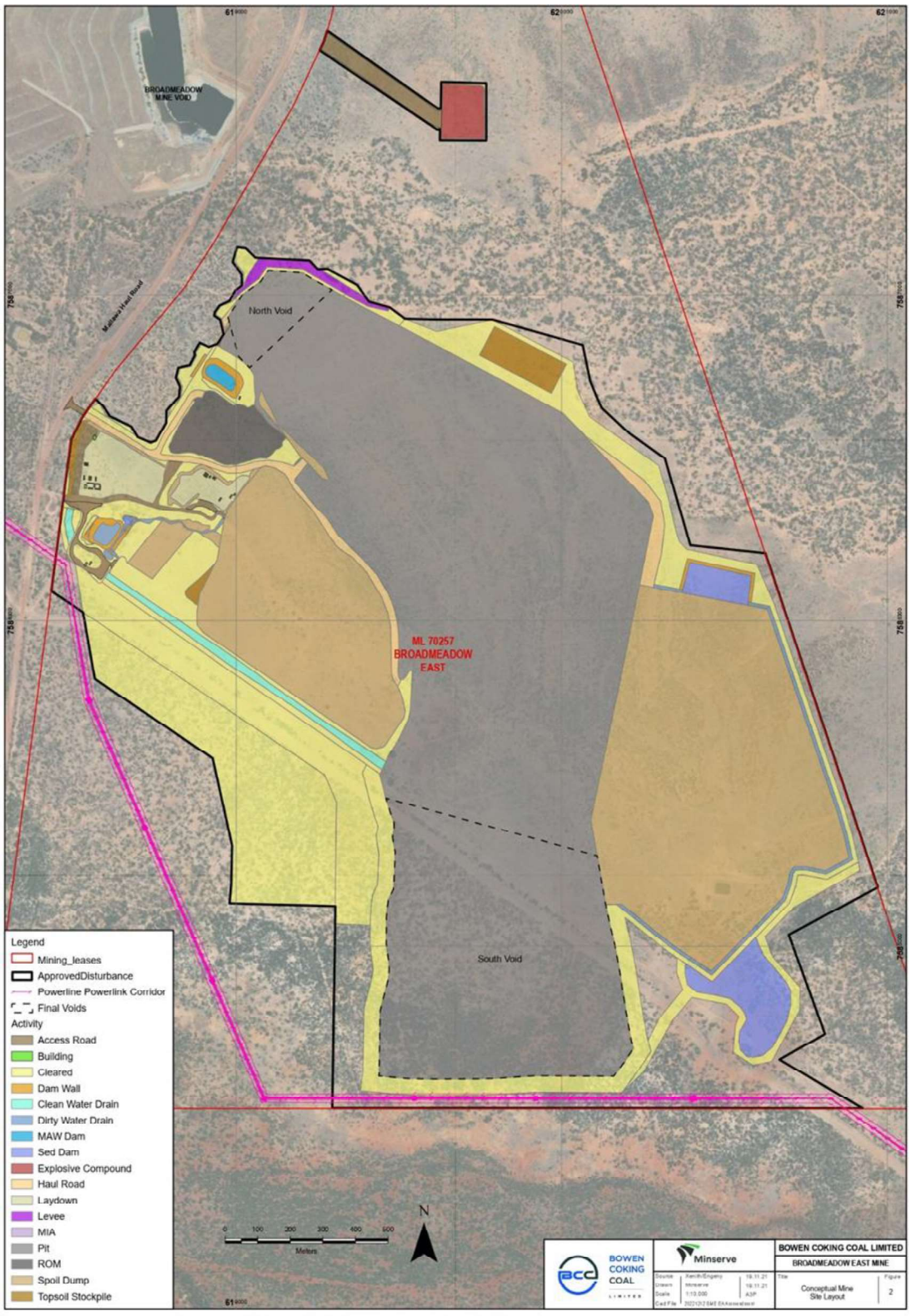


Figure 2 – Mine affected water release points and monitoring locations

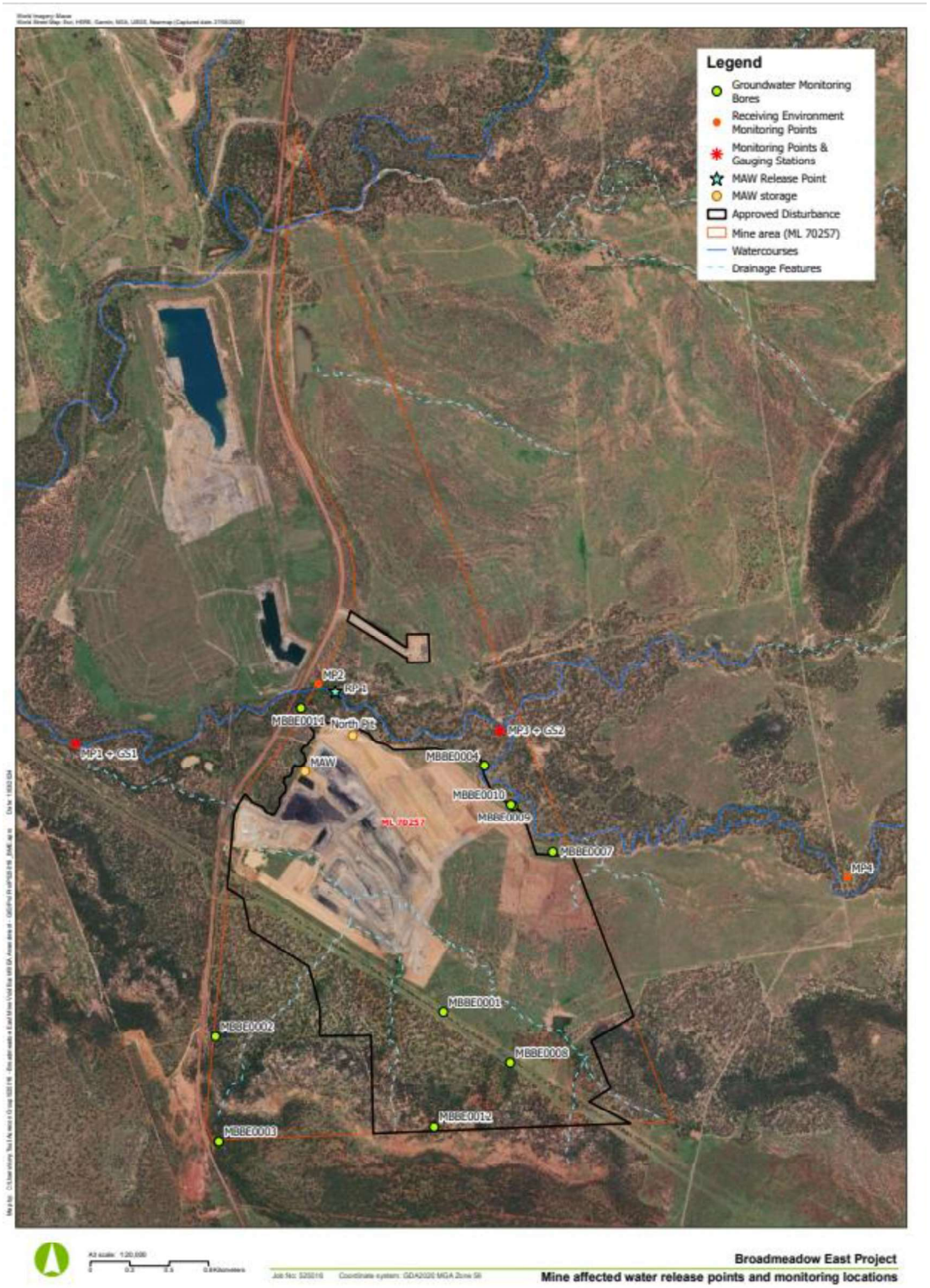


Figure 3 – Final landform, post closure

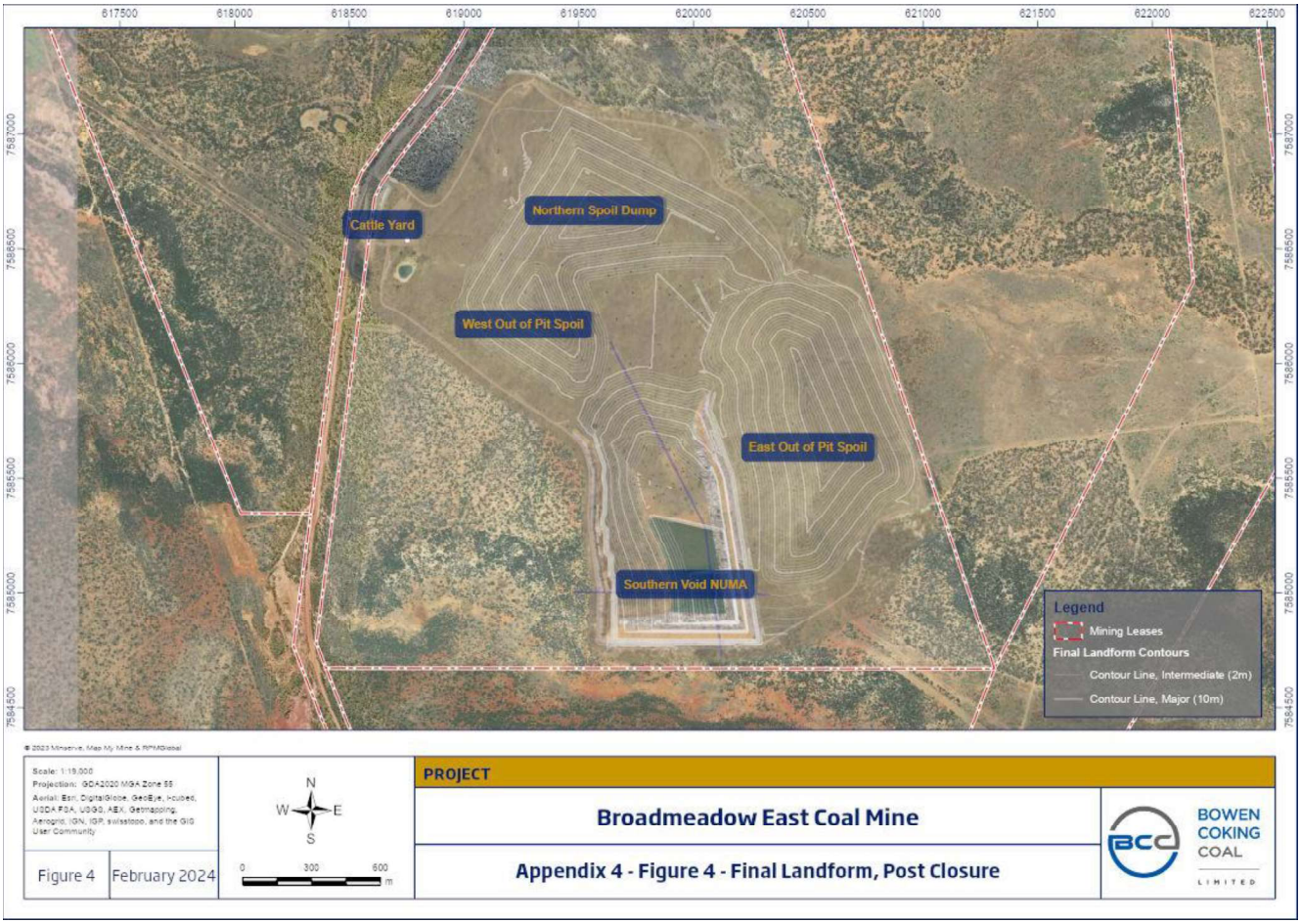
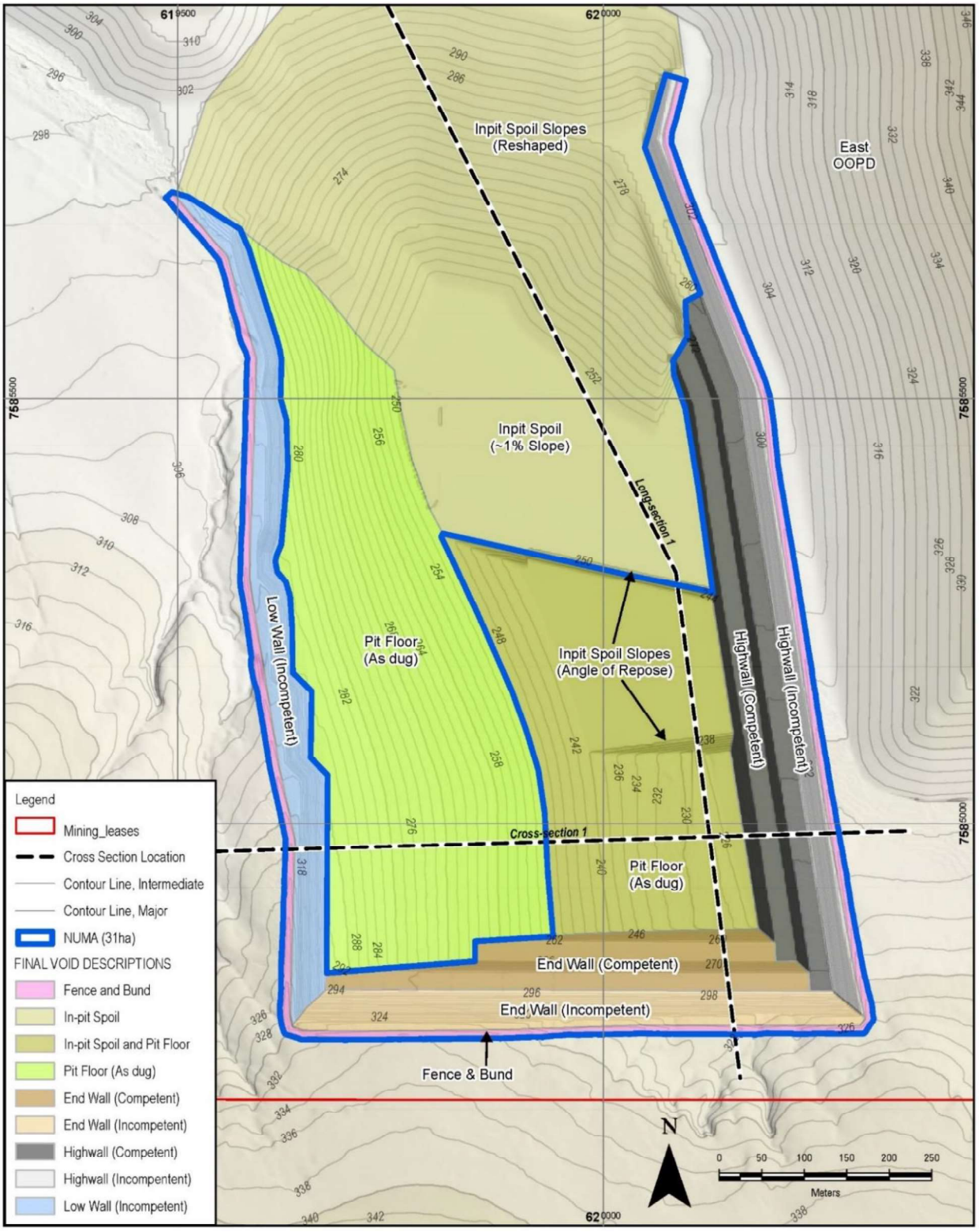


Figure 4 – Final landform design aspects for the southern void



Appendix 1

Table G1 – Post Mine Land Use (PMLU) and Non-Use Management Area (NUMA) 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.	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
				▪ Monitoring and reporting as per Rehabilitation Monitoring Program required under **Condition G15.**			
2. Northern Pit	The residual void created at the start of the pit development and used for bulk water storage over the operational mine life. Borders the central in-pit spoil dump. The final depth will be backfilled to 270 RL (above groundwater levels post closure).	4	4	▪ Dewater (for use in dust suppression) prior to rehab. ▪ Backfill to above the minimum level of 270 RL (mAHD). ▪ 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.	Low-intensity grazing	4	4
3. Central in-pit spoil dump	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. ▪ An appropriately qualified person to conduct a geotechnical assessment of the final landform. ▪ An appropriately 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 in-pit spoil dump 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.	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
				▪ 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.			
4. a. Southern Void - PMLU	The portion of the residual void remaining post mining at the southern pit extent that has a PMLU. Borders the central in-pit spoil dump.	4 &5	4	▪ General reshaping and pushing/trimming to achieve final landform. ▪ 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. ▪ Develop specific rehabilitation strategies that includes monitoring, surveying, stability analysis and reporting.	Low intensity grazing	4 (Low wall slopes)	N/A
4. b. Southern Void – NUMA	The portion of the residual void remaining post mining at the southern pit extent that is a NUMA. Refer **Figure 4 - Final landform**	4&5	4	▪ Minimised NUMA area based on economic, engineering, geotechnical, geochemical, surface water and groundwater technical reporting outcomes. ▪ Design final slope angles of the high, low and end walls to achieve geotechnical stability and safety.	Water Storage (NUMA)	N/A	N/A

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
	design aspects for the Southern Void, area labelled "NUMA".			▪ Residual void assessed to be geotechnically stable by an AQP achieving a Factor of Safety (FoS) of ≥1.5 for the in-situ pit walls. ▪ Assessment to confirm absence of active rill/gully erosion. ▪ Access to highwalls and end walls is restricted by fencing, signage and bund(s). ▪ Conduct long term water balance studies to confirm minimal risk of void overflow. ▪ Predictive modelling undertaken by an AQP, confirming that the voids will remain as a groundwater sink and that there is no risk of contamination post mining to surface waters or groundwaters. ▪ Backfill to a minimum of 225 RL and treat or remove exposed coal seams.			
4. 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.						
5. 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
6. 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.	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
				▪ Monitoring and reporting.			

Table G2 – PMLU and NUMA rehabilitation success criteria

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
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 topography 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 topography 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.

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
		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 ○ 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 ▪ 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).	▪ 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 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/NUMA	Disturbance Area	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 (Full Backfill)					
Low intensity grazing	Northern pit	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	Risk is as low as reasonably practical (ALARP) in accordance with *AS/NZS ISO 31000:2009 Risk Management.*

PMLU/NUMA	Disturbance Area	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. ▪ Full 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.	▪ 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

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
				▪ 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 ○ 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. ▪ Coal seams will be removed or covered in the backfilling process. ▪ No exposed hazardous material.	is not available, reference bores which have not been impacted by mining activities. ▪ Certification by an AQP that the groundwater level and 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	▪ Battered slopes with 60% perennial pasture biomass as per the closure and revegetation plans. ▪ Land Class 4 for grazing. ▪ Less than 5% of vegetative groundcover comprised of declared	▪ Results, that rehabilitated areas meet the land suitability assessment that meets class 4 or better for cattle grazing as defined by the Guideline for Agricultural Land Evaluation in Queensland (State Department of Queensland 2015).

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
			linkages with terrestrial vegetation.	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. ▪ A minimum of 4 palatable perennial pasture species are present within the seed mix during revegetation. ▪ Establishment of a mix of perennial grasses suitable for grazing in the area.	▪ Post closure flora and fauna ecological monitoring as per the monitoring plan.
Central in-pit spoil dump (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/NUMA	Disturbance Area	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 topography 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	▪ 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/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
				○ Molybdenum – 0.15mg/L ○ Selenium – 5 µg/L ○ Sulfate – 25 mg/L ○ Suspended Solids – 55 mg/L ▪ Groundwater aquifers maintain their pre-mining or reference bore water quality. ▪ Groundwater quality as per the water management plan. ▪ Coal seams to be treated, removed or covered in the backfilling process. ▪ 5m capping of rejects within central in-pit spoil dump 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 or 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.

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
Southern Void - PMLU					
Low-intensity grazing	Southern Void	Safe	Safety hazards in rehabilitation are as low as reasonably practical.	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	▪ Landform development and reshaping/re-profiling. Hydraulic assessment conducted to determine instability from floodwaters. ▪ Surface preparation. ▪ Minimise void area Stabilise walls and slopes.	▪ Install slopes and batters as per the void closure plan: ○ Overall slope: 15-30% ○ Vertical distance between berms: 20 m ○ Berm width: 5 m ○ Low wall final pit walls (Incompetent material): 45 degrees ○ Low wall length: 1050 m ○ 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	▪ Geotechnical report and certification from an appropriately qualified and experienced person AQP that the area has achieved stable condition, including: Residual void is geotechnically stable with FoS of ≥1.5 ▪ Absence of active rill/gully erosion ▪ Certification that erosion and sediment control measures have been installed and are operating as designed

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
				strategies included in the void closure plan. ▪ Geotechnical adequacy with a ≥1.5 Factor of Safety (FoS).	
		Non-polluting	Pit waters are contained such that they do not impact or interact surface or groundwater.	▪ The average erosion rate of 5t/ha/yr and not exceeding a maximum erosion rate of 10.0t/ha/yr for rehabilitated landforms to meet a stable condition, as determined by landform design. ▪ 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. ▪ Receiving environment contaminant limit: pH – 6.5-8.5 EC - baseflow 720 µS/cm high flow <250 µS/cm 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. ▪ 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 physically inert overburden with a minimum cover thickness of 5m.

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
				Sulfate - 25 mg/L Suspended Solids - 55 mg/L ▪ Groundwater aquifers maintain their pre-mining or reference bore water quality. ▪ Groundwater quality as per the closure water management plan. ▪ No exposed hazardous material.	
		Self-sustaining	a. Adequate revegetation. 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.	▪ 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 – NUMA					

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
Water Storage (Non-Use Management Area)	Southern Void	Safe	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: ○ Final pit walls (Competent material): 70 degrees ○ Final pit walls (Incompetent material): 45 degrees ○ Inpit spoil slope (unrehabilitated): Angle of repose nominally 37 degrees ▪ Maximum surface area (31 ha). ▪ Maximum depth (105 m). ▪ Maximum Void Lake equilibrium level will not reach 300 m AHD. ▪ 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. ▪ Partial backfill to a minimum of 225 RL as per the void water balance modelling.	▪ Geotechnical report and certification from an appropriately qualified and experienced person AQP that the area has achieved stable condition, including: • Residual void is geotechnically stable with FoS of ≥1.5 • Safety bund constructed in accordance with engineering 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
		Stable			

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
				▪ Geotechnical adequacy with a ≥1.5 Factor of Safety (FoS).	potentially contaminate any 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. ▪ Surface water quality of the receiving environment as per the water management plan. ▪ Groundwater aquifers maintain their pre-mining or reference bore water quality. ▪ Groundwater quality as per the closure water management plan. ▪ No exposed hazardous material. ▪ Certification from an AQP that the water level in each residual void; i Will not cause environmental harm to the surrounding environment;	▪ Surface water and groundwater trigger limits assessed as per the frequencies noted in the current EA. ▪ 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.

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
				ii. The voids act as groundwater sinks to the receiving groundwater environment; and iii. Predictive modelling of the final landform confirms that water levels will remain below the void spill level in a probable maximum precipitation storm event.	
		Self-sustaining	N/A	N/A	N/A
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	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.	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

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
	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.		b. Surface preparation.		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 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.
		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 ○ high flow <250 µS/cm ○ Turbidity - 50 NTU ○ Arsenic – 13 µg/L ○ Molybdenum – 0.15mg/L ○ Selenium – 5 µg/L ○ Sulfate - 25 mg/L ○ Suspended Solids - 55 mg/L ▪ 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.	
		Self-sustaining	Adequate revegetation.		
Water management Infrastructure (to be retained)					

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
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 agreement (to remain post closure). 2. Sediment Dam 4 (southeast).	Safe	a. Fencing in place where appropriate in consultation with the landholder b. Surface preparation. c. Landholder accepts the condition of the infrastructure including its structural integrity.	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.	
		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	a. Landform profiling in line with surrounding topography. b. All exploration drill holes have been rehabilitated.	▪ '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.
		Stable			

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
			c. Drill holes grouted and casings cut to ground level. d. Surface preparation.		▪ 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 accordance with relevant guidelines and standards. c. Surface run off is non-polluting to land and receiving waters[1]	**Receiving environment contaminant limit** - ○ pH – 6.5-8.5 ○ EC - baseflow 720 µS/cm ○ high flow <250 µS/cm ○ Turbidity - 50 NTU ○ Arsenic – 13 µg/L ○ Molybdenum – 0.15mg/L ○ Selenium – 5 µg/L ○ Sulfate - 25 mg/L ○ Suspended Solids - 55 mg/L ▪ 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.	▪ 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
		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)*	▪ 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.

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
				▪ 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).
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. ▪ 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.	▪ 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 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
		Non-polluting	a. Signage and fencing removed. b. Contaminated soil identified and removed in accordance with relevant guidelines and standards.		
		Self-sustaining	Adequate revegetation.		

PMLU/NUMA	Disturbance Area	Goals	Objectives/Indicators	Criteria	Validation Method
					Queensland (State Department of Queensland 2015).

END OF ENVIRONMENTAL AUTHORITY

TECHNICAL MEMORANDUM

TO: Richard Oldham
Bianca Voges-Haug
Aislinn Macintyre

DATE: 21 June 2024

FROM: Marlese Nel

FILE NO: DX70025A07

SUBJECT: Final Revision and Update of Groundwater Triggers for BME to support EA Amendment in response to Request for Information

1 INTRODUCTION

KCB Australia Pty Ltd (KCB) has been requested by Bowen Coking Coal (BCC) to assist with the revision and update of some of the groundwater triggers in support of an Environmental Authority (EA) Amendment application.

This document provides a brief background, an overview of the revision approach, calculation of proposed groundwater triggers, and recommendations are made for assigning trigger limits to new replacement bores drilled in October 2023.

2 BACKGROUND

BCC operates the Broadmeadows East (BME) Project under EA EA0002465 (February 2, 2023). Conditions D1 to D18 of the EA relate to groundwater.

Table D1 and Table D2 of the EA presents the current groundwater water level and quality triggers. These triggers were calculated in February 2022 based on data available at the time.

Condition D2 of the EA refers to the baseline groundwater monitoring program and in terms of triggers specifically states:

> *"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;"*

The purpose of this memorandum is to comply with condition D2 in support of an EA Amendment to update the groundwater level and quality triggers for the BME monitoring bores and to make recommendations regarding triggers for newly drilled replacement monitoring bores. It also provides support to the exceedance investigation for MBBE0001.

During the 2023 groundwater monitoring reporting period an exceedance was recorded as per definition in Condition D7:

> *"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".*

Compliance bore MBBE0001 recorded an exceedance for Electrical Conductivity (EC) and as per EA requirements a notification was made vis WaTERS and a subsequent investigation performed and submitted to DES within the required timeframe.

3 HYDROGEOLOGICAL CONCEPTUAL SUMMARY

3.1 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 was sourced from the Scientific Information for Landowners database (SILO) at the Wentworth Station, located close to the Project area.

The rainfall data was analysed to produce a cumulative rainfall departure (CRD) trend (Figure 3.1). 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.

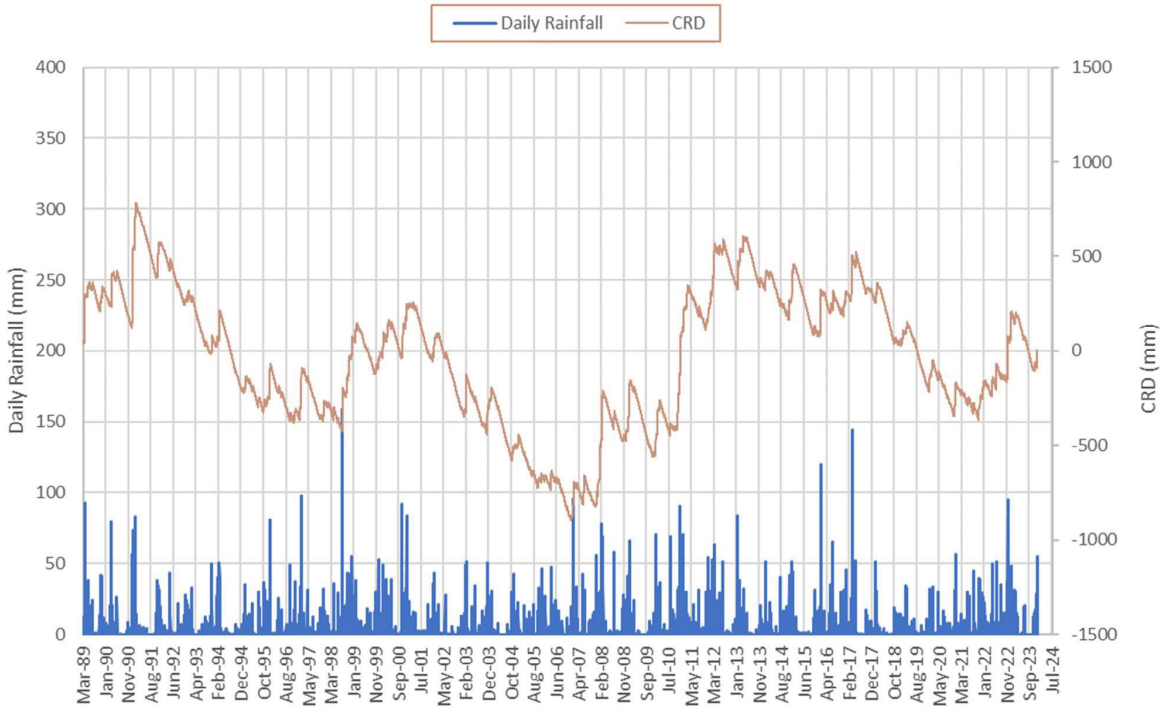


Figure 3.1 Daily rainfall and CRD, January 1989 to December 2023, Wentworth Station (SILO)

Key climatic trends observed in the period from the CRD trend are:

- 2002 to 2007: A 6-year decreasing trend, where below average rainfall occurred.
- 2007 to 2010: A 4-year increasing trend, but rainfall still below average.

- 2010 to 2019: A 10-year above average rainfall period, including some large rainfall events.
- 2019 to 2022: A 4-year below average rainfall period.
- 2023 to present: A short period of above average rainfall.

The impact of seasonality, long term climatic trends and above average rainfall events could manifest in changes in groundwater quality and should be taken into consideration when evaluating the groundwater chemistry.

3.2 Hydrostratigraphy

The following hydrostratigraphic units have been identified at BME:

- ***Quaternary Alluvium:*** a unit associated with the ephemeral watercourses in the Project area. The regional water table is typically located several metres below the base of the alluvium, which has a thickness ranging from 3 m to 4 m and is typically dry and unsaturated.
- ***Tertiary Sediments:*** a unit with a heterogenous profile of semi-consolidated quartz sandstone, clayey sandstone, mudstone and conglomerate, fluvial lacustrine sediments, and minor interbedded basalt. This unit is predominantly located to the south of the Project area and has a thickness of up to 15 m. As with the alluvium, these are typically located above the regional groundwater table and are therefore generally dry.
- ***Tertiary Basalt:*** a unit 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. The hydraulic properties of the basalt can vary considerably as groundwater is primarily stored within highly compartmentalised fractures and vesicular zones. Tertiary basalt was identified only in one bore in the southwest corner of the mining lease, where it is 15 m thick and dry.
- ***Triassic Rewan Group:*** a unit that is recognised as a regional aquitard and acts as a confining unit overlying the Permian sediments. The Rewan 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.
- ***Permian Coal Measures:*** a unit that comprises of alternating layers of fine to medium grained sandstone, siltstone and coal, including the target Leichhardt seam 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. Individual coal seams form the principal water bearing strata within the coal measures and are therefore typically saturated and the majority of the monitoring bores are screened within this unit.

The geology encountered, groundwater qualities and dissolved metal concentrations are not unexpected based on the geology of the site and dissolved metal concentrations in the groundwater are reflective of local geology and local pH.

3.3 Potential sources of groundwater quality impact

Processing and associated management of rejects from processing activities will be handled offsite at an existing facility. Therefore, the potential for contamination of the groundwater will be in relation to spills associated with hydrocarbon and chemical usage at the Project site. However, the storage of hydrocarbons and chemicals will be managed in accordance with standard management practices, including the use of bunding and the immediate clean-up of spill, which are typically legislated requirements at mine sites.

OOPD's (stockpiles and dumps) could impact the groundwater quality when leachate from the OOPDs' reaches the groundwater level. The hydrogeological environment on the site will determine how fast (based on hydraulic conductivity) and how far (extent of potential impact) this potential impact could occur.

4 GROUNDWATER MONITORING PROGRAM

4.1 Current EA monitoring bores

Condition D3 states that 'groundwater quality and levels must be monitored at the locations and frequencies defined in Table D1 – Groundwater monitoring locations and frequency'. Further requirements for groundwater quality monitoring and groundwater level monitoring are provided in Condition D4 and D5 respectively.

The current monitoring network as presented in Table D1 of the EA is summarised in Table 4.1.

Table 4.1 Groundwater Monitoring Locations and Frequency (Adapted from Table D1 of the EA February 2, 2023)

Monitoring ID	Easting (GDA20)	Northing (GDA20)	Monitoring Frequency
Compliance Bore			
MBBE0001	619884	7585428	▪ Quarterly measurements of SWLa ▪ Quarterly EC and pH ▪ Six-monthly for remaining analytes
MBBE0007	620615	7586415	
EA Monitoring Bore			
MBBE0002	618436	7585329	▪ Quarterly measurements of SWL ▪ Quarterly EC and pH ▪ Six-monthly for remaining analytes
MBBE0003	618431	7584664	
MBBE0004	620205	7586976	
MBBE0006	619173	7587205	
MBBE0008	620294	7585092	
BDW5C	619687	7586758	
BDW8C	619782	7585651	
BDW172(32)	619376	7586650	
BDW172(54)	619376	7586650	

a. SWL = Standing Water Level

Baseline monitoring data at BME is available for the EA monitoring bores for the time periods as summarised in Table 4.2.

Table 4.2 Baseline monitoring data time periods for EA bores

Monitoring ID	Monitoring period	
	From	To
BDW172(32)*	Aug-99	Feb-22
BDW172(54)*	Aug-99	Feb-22
BDW5C*	Jan-06	Sep-22
BDW8C*	Jan-06	Aug-23
MBBE0001**	Feb-21	2024
MBBE0002b	Feb-21	Current
MBBE0003	Feb-21	Current
MBBE0004	Feb-21	Current
MBBE0006*	Feb-21	Sep-23
MBBE0007	Apr-21	Current
MBE00008	Aug-21	Current

*mined through
**planned to be mined through

Some data gaps exist for BDW172(32), BDW172(54), BDW5C and BWD8C; before BCC took ownership of the mine in January 2021. Since then, monitoring has been recorded and reported as per the EA requirements.

Due to progression of mining operations, some of the existing EA monitoring bores have been mined through. Four (4) new replacement monitoring bores were therefore drilled in October 2023 to update the groundwater monitoring network.

The updated monitoring network locations are shown in Figure 4.5.

4.1.1 Groundwater Monitoring Results

MBBE0001

Groundwater quality data from February 2021 to February 2024 for compliance bore MBBE0001 indicates a slight increase in electrical conductivity (EC). The minimum and maximum over this period are 801 µS/cm and 947 µS/cm respectively.

The EC concentrations and the current water quality trigger limit are shown in Figure 4.1 and a summary of the results for analytes as listed in Table D2 of the EA for this bore is shown in Table 4.3 (values in exceedance of water quality trigger limit as stipulated in EA highlighted in **red**).

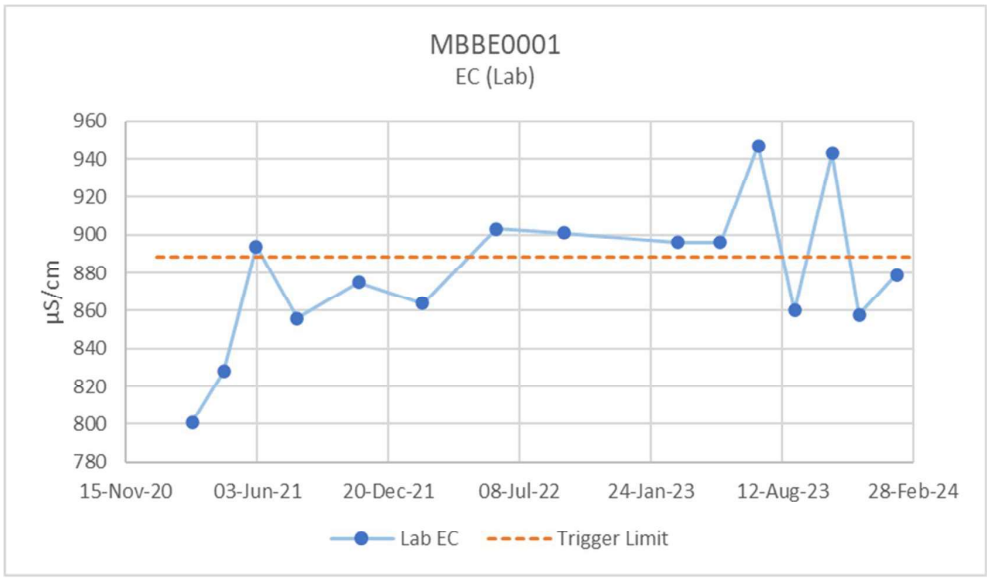
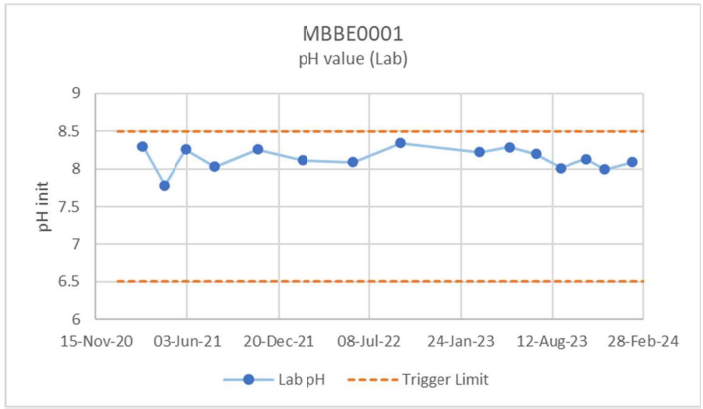


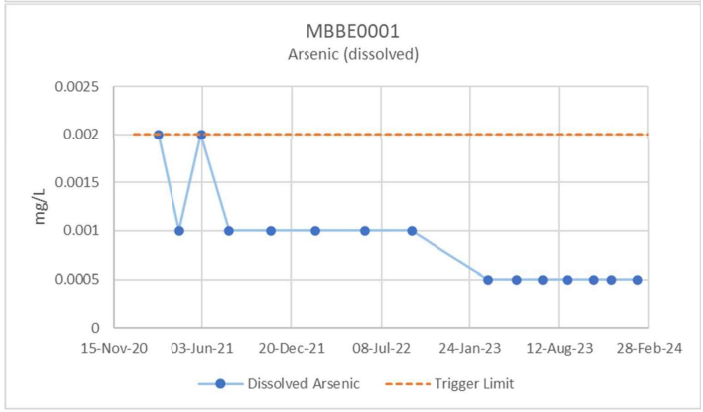
Figure 4.1 Electrical conductivity (EC) for compliance bore MBBE0001 for total monitoring period

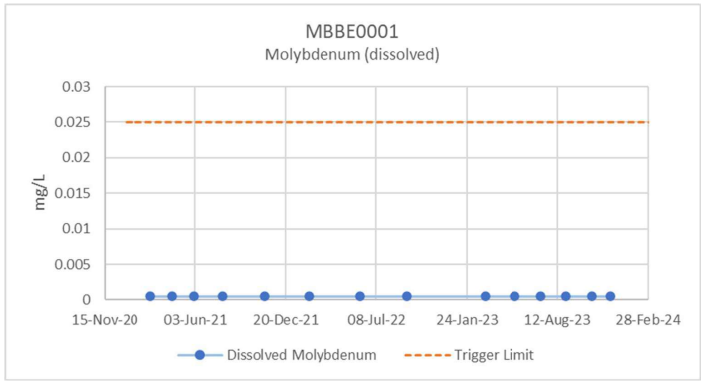
Table 4.3 Laboratory results for water quality triggers (as per Table D2 EA0002465) for MBBE0001 over monitoring period

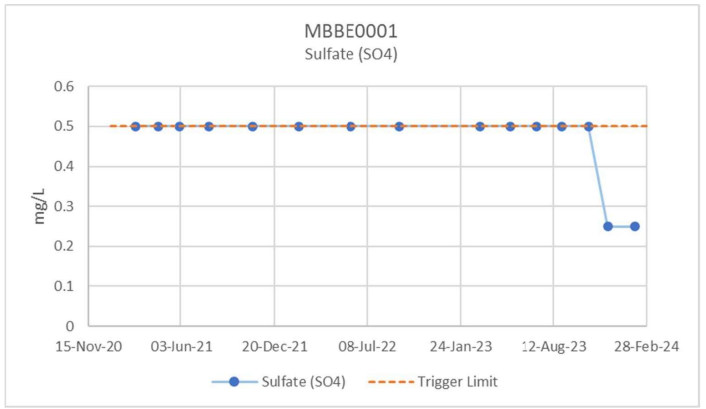
Trigger Parameter	Unit	MBBE0001														
		Feb 2021	April 2021	June 2021	Aug 2021	Nov 2021	Feb 2022	June 2022	Sept 2022	March 2023	May 2023	July 2023	Aug 2023	Oct 2023	Dec 2023	Feb 2024
pH	pH units	8.3	7.78	8.26	8.03	8.26	8.11	8.09	8.34	8.22	8.29	8.2	8.01	8.13	7.99	8.09
Electrical Conductivity	µs/cm	801	828	**894**	856	875	864	**903**	**901**	**896**	**896**	**947**	860	**943**	858	879
Sulfate	mg/L	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]
Arsenic	mg/L	<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
Aluminium	mg/L	0.07	0.08	0.08	0.06	0.04	0.03	0.03	0.01	<0.01	0.02	0.02	<0.01	0.02	<0.01	<0.01
Molybdenum	mg/L	<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
Selenium	mg/L	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	NR

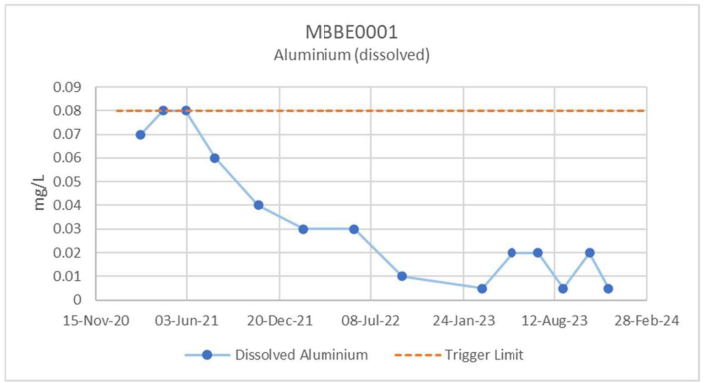
1. Note: where exceedances are at the limit of reporting of the lab, halving of the value results in less than or equal to the trigger value.
NR = No Resul











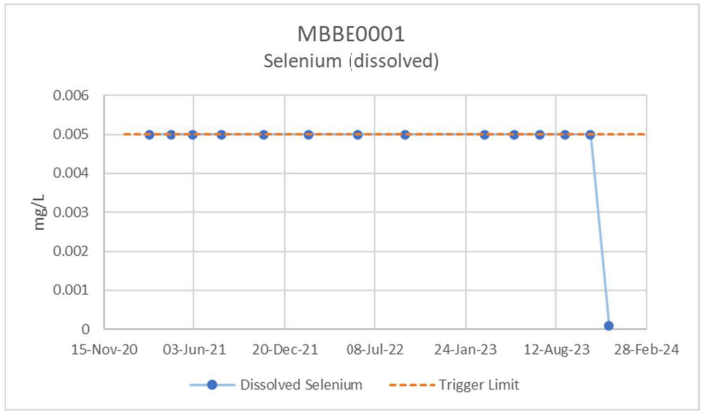


Figure 4.2 Groundwater Quality Monitoring Results and Compliance Triggers

MBBE0007

Groundwater quality data from February 2021 to February 2024 for compliance bore MBBE0007 indicates a slight increase in sulfate (SO_4). The minimum and maximum over this period are 850 mg/L and 1,060 mg/L respectively.

The sulfate concentrations and the current water quality trigger limit are shown in Figure 4.3 and a summary of the results for analytes as listed in Table D2 of the EA for this bore is shown in Table 4.4 (values in exceedance of water quality trigger limit as stipulated in EA highlighted in **red**).

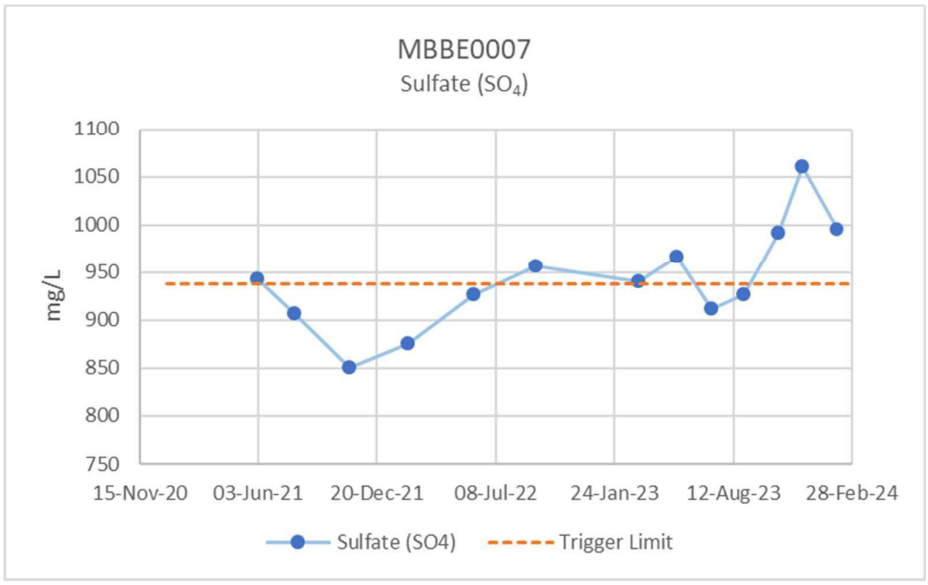
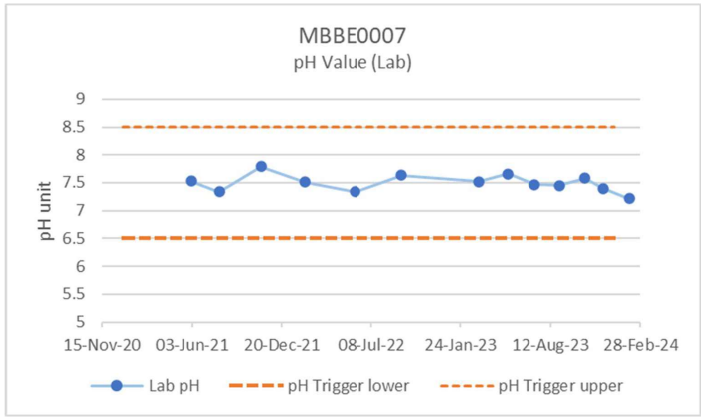
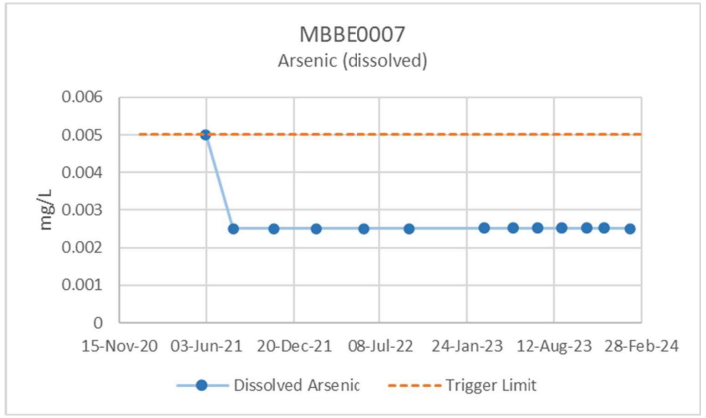


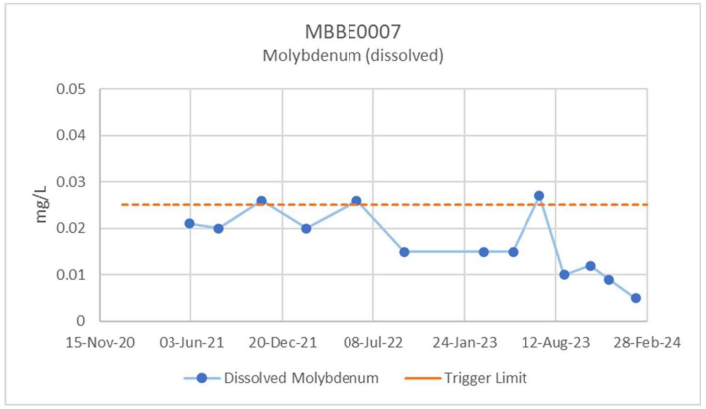
Figure 4.3 Sulfate for compliance bore MBBE0007 for total monitoring period

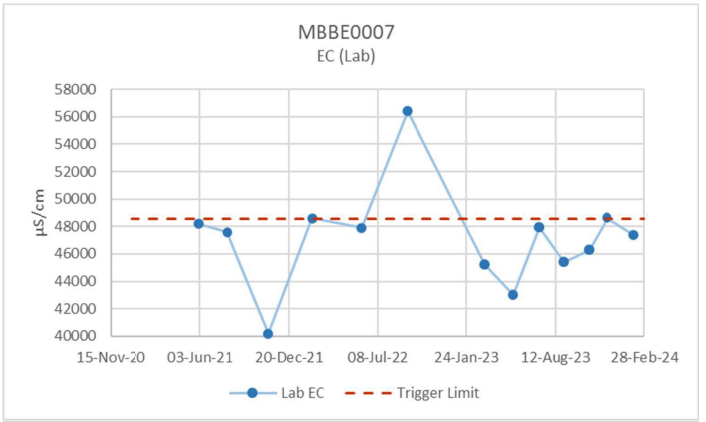
Table 4.4 Laboratory results for water quality triggers (as per Table D2 EA0002465) for MBBE0007 over monitoring period

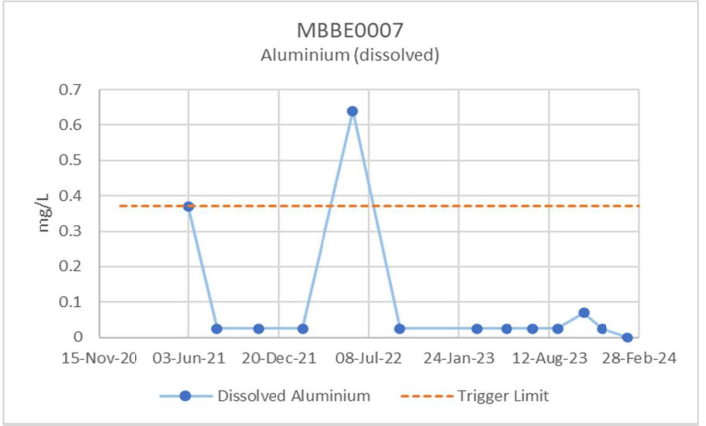
Trigger Parameter	Unit	MBBE0007												
		June 2021	Aug 2021	Nov 2021	Feb 2022	June 2022	Sept 2022	March 2023	May 2023	July 2023	Aug 2023	Oct 2023	Dec 2023	Feb 2024
pH	pH units	7.53	7.34	7.79	7.51	7.34	7.63	7.52	7.66	7.47	7.45	7.58	7.4	7.22
Electrical Conductivity	µs/cm	48,200	47,600	40,200	**48,600**	47,900	**56,400**	45,200	43,000	47,900	45,400	46,300	**48,600**	47,400
Sulfate	mg/L	**943**	907	850	876	926	**956**	**940**	**966**	912	927	**991**	**1060**	**996**
Arsenic	mg/L	<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
Aluminium	mg/L	0.37	<0.05	<0.05	<0.05	0.64	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05
Molybdenum	mg/L	0.021	0.02	0.026	0.02	0.022	0.015	0.015	0.015	0.027	0.01	0.012	0.009	0.005
Selenium	mg/L	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.002	<2











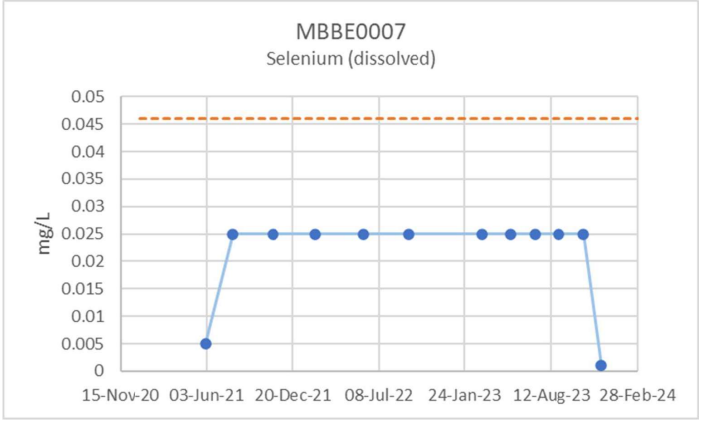


Figure 4.4 Groundwater Quality Monitoring Results and Compliance Trigger

4.2 Updated Groundwater Monitoring Network

The current network as stipulated in Table D1 of EA includes 11 monitoring bores screened in five hydrostratigraphic units at varying depths.

Recent changes were made to the network:

- Various monitoring bores were mined through due to the progression of mining activities.
- Drilling of four (4) replacement bores in Q4 2023.

The updated BME monitoring network now consists of 10 monitoring bores screened in five hydrostratigraphic units at varying depths. The updated network is presented in Figure 4.5 and summarised in Table 4.5.

One of the current compliance bores, MBBE0001, is planned to be decommissioned in 2024 and replaced by bore MBBE0009 at that time. From December 2023, until monitoring is stopped at MBBE0001, these two bores are monitored concurrently to ensure continuous records for EA compliance.

Table 4.5 Updated Monitoring Bore Network Details and Monitoring Requirements Q1 2024

Monitoring Point	Easting (GDA20)	Northing (GDA20)	Screened Interval (mbgL*)	Aquifer / Monitored Interval	TOC[3] elevation (mAHD)[4]	Monitoring Frequency		Comments
						Quarterly	Six monthly	
Updated EA Monitoring Bores								
MBBE0002b[1]	618436	7585329	10.0 to 13.0	Tertiary Sediments	323.7	pH and EC	All other analytes	Ongoing
MBBE0003[1]	618431	7584664	4.0 to 7.0	Basalt	345.7	pH and EC	All other analytes	Ongoing
MBBE0004[1]	620205	7586976	2.0 to 5.0	Alluvium	290.8	pH and EC	All other analytes	Ongoing
MBBE0008	620294	7585092	130.0 to 133.0	Rangal Coal Measures	305.2	pH and EC	All other analytes	Ongoing
MBBE0010[5]	620362	7586723	52.0 to 58.0	Rewan Group	292.39	pH and EC	All other analytes	Monitoring started Oct 2023
MBBE0011[5]	619058	7587386	3.0 to 6.0	Alluvium	285.13	pH and EC	All other analytes	Monitoring started Oct 2023
MBBE0012[5]	619797	7584702	51.0 to 57.0	Rangal Coal Measures	336.42	pH and EC	All other analytes	Monitoring started Oct 2023
Compliance Bores								
MBBE0001[2]	619884	7585428	63.0 to 66.0	Rangal Coal Measures	305.2	pH and EC	All other analytes	Ongoing until mined through
MBBE0009[5]	620376	7586716	104.0 to 110	Rangal Coal Measures	292.46	pH and EC	All other analytes	Monitoring started Oct 2023.
MBBE0007	620615	7586415	40.0 to 46.0	Rewan Group	297.9	pH and EC	All other analytes	Ongoing
Surrounding Bores								
MBBE0005[1]	620519	7586210	4.0 to 7.0	Rewan Group	297.1	Not sampled		Ongoing

1. Some bores are often dry and unavailable for water levels.
2. MBBE0001 to be replaced by MBBE0009, already drilled in Oct 2023. Continue monitoring of both until MBBE0001 is mined out (2024).
3. TOC – top of casing.
4. mAHD – meters above Australian Height Datum
5. Replacement monitoring bores (Drilled October 2023)

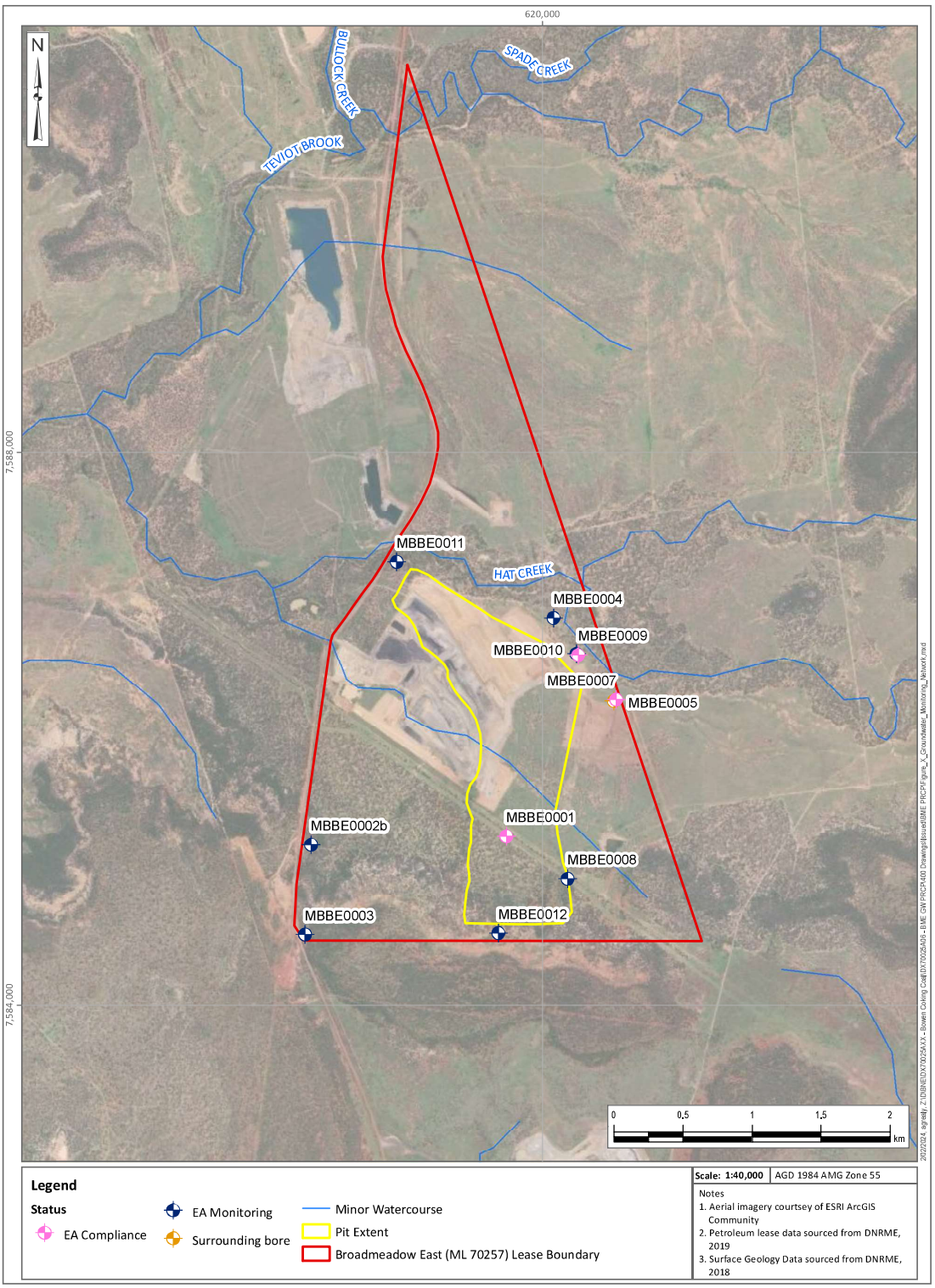


Figure 4.5 Updated Groundwater Monitoring Network (as in Q1 2024)

5 INVESTIGATION TRIGGER VALUES

5.1 Overview

The DES 2021 Guideline explains that *'trigger values are typically the numerical criteria that, if exceeded, provide an alert of a change that warrants further investigation for the contaminant being measured'.*

The Guideline offers two alternative methods: 'default values' or 'site-specific'. Where sufficient data is available, the site-specific approach is preferred, and this is the approach adopted for BME. The Guideline explains that groundwater quality can be highly variable. The variability can be influenced by local geology, residence time in the aquifer and groundwater-rock interactions, which can result in naturally elevated concentrations (e.g. salinity), dissolved nutrients and metals. As groundwater quality can be variable, the Guideline states that the use of 'default' values, such as those derived from the Queensland Water Quality Guidelines (DEHP 2013), and Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) for the protection of freshwater aquatic ecosystems or stock drinking water and the Australian Drinking Water Quality Guidelines (NHMRC 2018) 'may not always be appropriate' (page 1). In these cases, site-specific values should be calculated which are aquifer-based and operational area-defined, as these are considered more representative.

The DES guidance document (2021) identifies that:

> *"Trigger values should be fit for purpose and conservative enough such that, when applied, they provide an early warning of emerging potential impacts to groundwater. Applying triggers that are set too high may not be sensitive enough to identify current or emerging contamination issues. Conversely, if triggers and limits are set too low, natural variability may be mistaken for contamination events and result in unnecessary reporting and investigation."*

5.2 Methodology

This assessment was undertaken in a manner that is consistent with the DES guidance document (2021). An approach has been adopted that considers the site-specific conditions and is targeted towards understanding trends, providing BME with appropriate triggers to initiate actions.

DES (2021) recommends that groundwater quality assessment be based on comparing a number of consecutive sample tests at investigation trigger bores to a limit based on percentile calculations. This approach is aimed at reducing the probability of a false positive whilst ensuring that the approach is sufficiently sensitive to detect potential impacts.

5.2.1 Adoption of Percentiles

The approach is based on combining the ANZECC 2000 methodology, adapted control charting approaches, and statistics. The approach includes the calculation of the following:

- Limit - maximum (95th percentile) of existing time series monitoring data.
- pH limits based on ANZECC freshwater aquatic ecosystem trigger value (ANZG 2018).

5.2.2 Data Used to Develop Trigger Levels

The following approach was used to develop the trigger levels:

- All monitoring data from January 2021 to February 2024 was compiled into one data set for consideration.
- Anomalous values or outliers were removed for individual bores prior to calculation of the trigger value (consistent with guidance provided by DSITI 2017).
- If <50% of the dataset were non-detects (under the Limit of Recognition (LoR)) the non-detect values were set at half of the detection concentrations.
- If >50% of the dataset were non-detects (under the LoR), these values were removed from the dataset before site-specific triggers were calculated on the remaining data.
- If there are less than eight (<8) data points available that are greater than LoR, the guidelines recommend using the default or WQO until sufficient data is collected to calculate a site-specific value.
- If there are no default guidelines for a given analyte or if the default guideline is less than the LoR, KCB recommends the LoR to be used as the trigger limit until sufficient data is collected to calculate a site-specific value.
- If more than one species (e.g. As(III) and AS(V)) and we don't know which one the laboratory will analyse, then the more stringent of the default values is set as trigger value.

5.3 Groundwater Contaminant Triggers

The 'source-pathway-receptor' approach has been adopted to assess the need for trigger values in accordance with the guidelines wherein site activities, the hydrogeological environment and identified environmental receptors are considered. This approach reviews environmental values, available data and existing groundwater quality changes to choose appropriate groundwater quality trigger levels.

The primary source of potential contaminants associated with the Project may include spoil dumps and surface water management facilities. However, throughout the duration of Project operation, and during mine closure, groundwater flow will be towards the proposed pit / post-closure pit voids (KCB 2023). This is due to dewatering activities associated with the pit development causing a drawdown in the local groundwater regime; and the final post-closure groundwater equilibrium level resulting in the development of a localised groundwater sinks in vicinity of the Project area. Therefore, throughout operation of the Project, and into mine closure, there will be no groundwater flow pathway from the Project area to downstream receptors.

The parameters chosen for trigger development (pH, EC, SO_4, Al, As, Fe) are appropriate for the contaminants of concern for coal mining operations.

Table 5.2 provides a summary of all the data points used in the calculation of the trigger limits for compliance bores MBBE0001 and MBBE0007.

The initial calculated groundwater quality trigger values for the indicator parameters for the monitoring bores are shown in Table 5.3 and are based on the monitoring data collected at the

specific bores between January 2021 to February 2022. This has been taken up in the EA of 3 February 2023.

Since February 2022, additional water quality data has become available. These results have been evaluated and trigger values updated where applicable according to the DES 2021 guideline document. These updated triggers are summarised in Table 5.4.

The WQOs for the Isaac River Groundwaters (Zone 34) have been identified for both the shallow (<30 m) and deep systems (>30 m) (DEHP, 2011).

The ANZG default water quality guidelines for the groundwater quality parameters have been identified for aluminium, silver, arsenic, mercury, antimony, molybdenum, and selenium based on a moderately disturbed system. These are presented in Table 5.1.

There are no default water quality guidelines or objectives for potassium, carbonate, and total petroleum hydrocarbons (TPH).

Table 5.1 Default Guidelines and WQOs for Key Analytes

Indicator	Default Guidelines and WQOs						
	ANZG Default (mg/L) (Slightly to Moderately Disturbed – 80th percentile)	Isaac River Groundwaters (Zone 34)					
		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 (uS/cm)		498	2150	8910	3419	6100	16000
Calcium (mg/L)		18	84	215	46	145	442
Magnesium (mg/L)		27	108	389	35	115	491
Sodium (mg/L)		135	747	1500	480	1100	2565
Potassium (mg/L)		-	-	-	-	-	-
Chloride (mg/L)		171	1309	3185	753	1900	5905
Sulphate (mg/L)		12	140	318	25	138	398
Carbonate (mg/L)		-	-	-	-	-	-
Bicarbonate (mg/L)		187	536	878	188	330	650
Iron (mg/L)		0.000	0.030	0.140	0.000	0.050	0.246
Aluminium (mg/L)	0.055*	-	-	-	-	-	-
Silver (mg/L)	0.00005*	-	-	-	-	-	-
Arsenic (mg/L)	0.013*^	-	-	-	-	-	-
Mercury (inorganic) (mg/L)	0.00006#	-	-	-	-	-	-
Antimony (mg/L)	0.009	-	-	-	-	-	-
Molybdenum (mg/L)	0.034	-	-	-	-	-	-
Selenium (mg/L)	0.005#	-	-	-	-	-	-
Total Petroleum Hydrocarbons (ug/L)	-	-	-	-	-	-	-

* 95% level of species protection recommended for slightly to moderately disturbed ecosystems.

^ The ANZG 2018 specify different toxicant trigger values for arsenic Arsenite As(III) and Arsenate As(V); when the speciation of arsenic is unknown, as in this case, the more conservative trigger value (Arsenate As(V)) should be used.

\# To account for the bioaccumulating nature of this toxicant, it is recommended that the 99% species protection level DGV is used for slightly to moderately disturbed systems.

Table 5.2 Summary of data point statistics for compliance bore trigger calculations

Compliance Parameter	pH	EC	Sulfate (SO4)	Aluminium (dissolved)	Arsenic (dissolved)	Molybdenum (dissolved)	Selenium (dissolved)
MBBE0001							
Amount of data points on 23 Feb 2024	16	16	16	16	16	15	14
Limit of Reporting	0.01	1	0.1*	0.01	0.001	0.001	0.01
% of dataset <LoR	0	0	100	25	56	73	100
Amount of data points usable	16	14	0	12	7	4	0
Other reason for exclusion of data point-/s		2 outliers					
Proposed Trigger	**6.5 - 8.5**	**901.7**	**Default***	**0.08**	**Default***	**Default***	**Default***
MBBE0007							
Amount of data points on 23 Feb 2024	13	13	13	13	13	13	13
Limit of Reporting	0.01	1	0.1*	0.01	0.001	0.001	0.01
% of dataset <LoR	0	0	0	76	92	7	84
Amount of data points used	13	12	10	3	1	12	1
Other reason for exclusion of data point-/s		Outlier	Outliers, rain dilution				Outlier
Proposed Trigger	**6.5 - 8.5**	**48,600**	**961.5**	**Default***	**Default***	**0.02**	**Default***

*If >50% of the dataset were non-detects (under the LoR), these values were removed from the dataset before site-specific triggers were calculated on the remaining data. If less than 8 points then available, the default or WQO is allocated as trigger until sufficient data (>8 points) are available.

Table 5.3 Current Groundwater Quality Trigger Values (Table D-2 from EA)

Monitoring Point	Parameter	pH	EC	Sulfate (SO_4)	Arsenic	Aluminium	Molybdenum	Selenium	Major ions
	Sample	Range	Max	Max	Max	Max	Max	Max	
	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	Interpretation Only
MBBE0007			48,540	937.6	0.005	0.37	0.025	0.046	

Table 5.4 Proposed Groundwater Quality Trigger Values

Monitoring Point	Parameter	pH	EC	Sulfate (SO_4)	Arsenic	Aluminium	Molybdenum	Selenium	Major ions
	Sample	Range	Max	Max	Max	Max	Max	Max	
	Unit	pH units	(µS/cm)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
MBBE0001		6.5 – 8.5	901.7	398*	0.013*	0.08	0.034*	0.013*	Interpretation Only
MBBE0007			48,600	961.5	0.013*	0.055*	0.02	0.013*	
MBBE0009			16,000*	398*	0.013**	0.055**	0.034**	0.005**	

*default WQO value
**default values ANZECC/ARMCANZ (2000)

5.4 Groundwater Level Triggers

KCB developed a numerical groundwater model for the BME project site in September 2023 as part of the Progressive Rehabilitation and Closure Plan (PRCP). After calibration of the model, groundwater level predictions were done for different times during mining operations, as well as post-closure. Maximum drawdown levels for each hydrostratigraphic unit are shown in Figure 5.1 to Figure 5.5.

These model results were used to determine maximum drawdown for the newly drilled bores, MBBE0009, MBBE0010, MBBE0011 and MBBE0012. Recommended groundwater level triggers are summarised in Table 5.5. Groundwater trigger levels for BME compliance bores have also been updated and these are presented in Table 5.6.

No pre-mining baseline standing water level can be allocated to MBBE0011 since the bore was dry after construction and subsequent monitoring rounds confirmed the absence of groundwater in the bore.

Table 5.5 Predicted Groundwater Levels with Proposed Trigger Levels

Purpose	Bore ID	Ground level elevation (mAHD)	Bore depth (meters below surface)	Baseline SWL (mbTOC)	Groundwater Trigger Elevation* (mAHD)
Investigation Trigger	MBBE0010	291.63	58	21.36	267.23
Investigation Trigger	MBBE0011	284.34	8	N/A	N/A
Investigation Trigger	MBBE0012	335.72	58	46.43	280.23

N/A – Not Applicable, bore dry
*based on numerical model predictions for maximum drawdown

Table 5.6 Proposed Groundwater Trigger Levels for Compliance Bores

Purpose	Bore ID	Ground level elevation (mAHD)	Bore depth (meters below surface)	Baseline Water Level (mbTOC)	Baseline Water Level (mAHD)	Groundwater Trigger Elevation* (mAHD)
Compliance Bore	MBBE0001	304.5	67.6	17.11	288.1	241
Compliance Bore	MBBE0007	297.10	52	18.22	279.6	273
Compliance Bore	MBBE0009#	291.65	166	24.74**	266.1	267.48

* Based on numerical model predictions for maximum drawdown
**Used first recorded manual dip water level after bore drilled and before mining commenced
to replace MBBE0001 as Compliance Bore in future

It is recommended that the EA be amended so that any exceedance of the predicted maximum groundwater drawdowns be used as trigger values to indicate excessive drawdown. The groundwater model is conservative, and therefore, the predicted maximum drawdown values should not be reached under currently anticipated conditions. To avoid false triggering, triggers for groundwater levels are defined to occur when average values exceed the groundwater trigger elevation for three or more consecutive monitoring rounds.

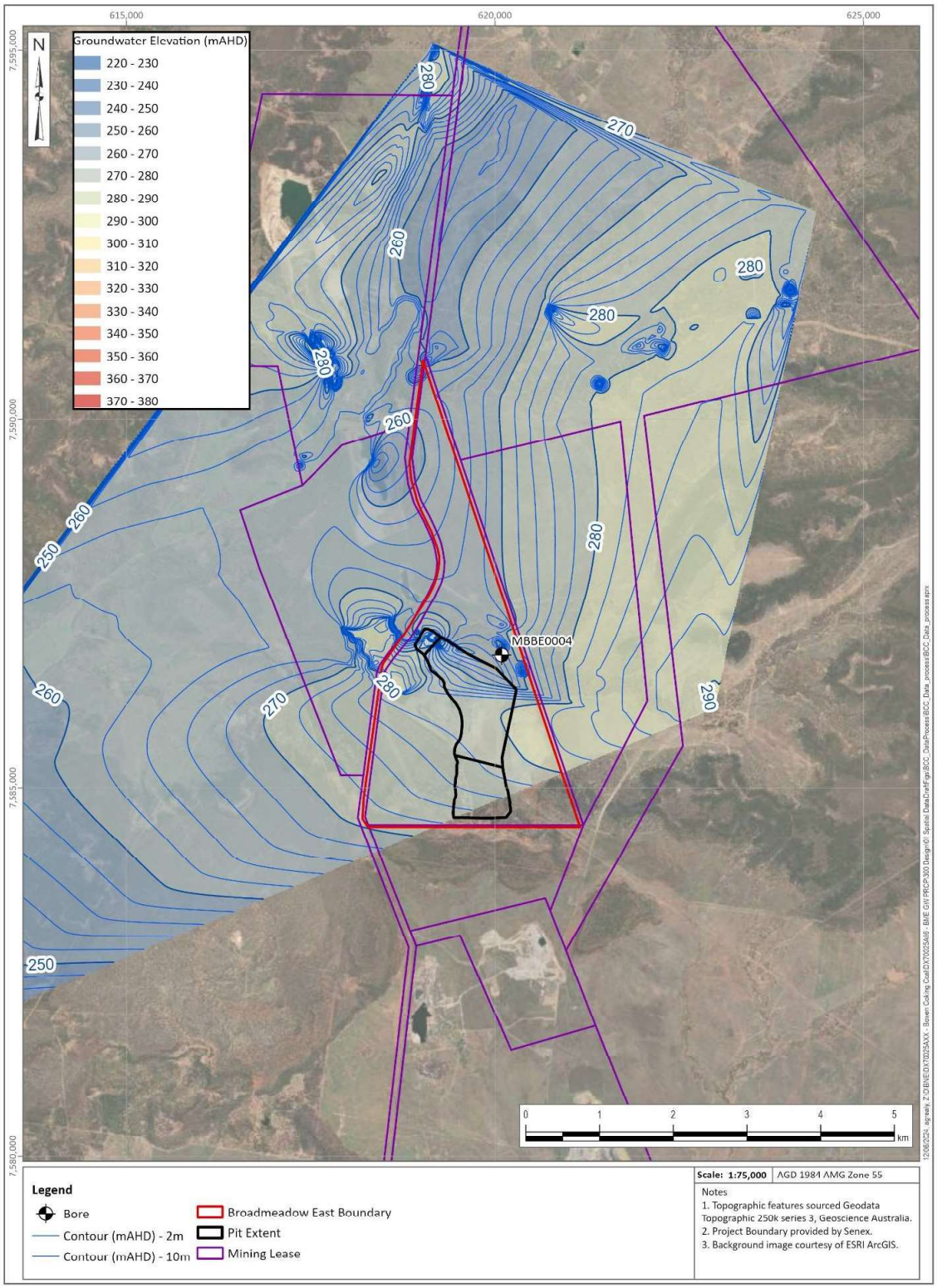


Figure 5.1 Predicted Maximum Drawdown Elevation in Layer 1 – Quaternary Alluvium

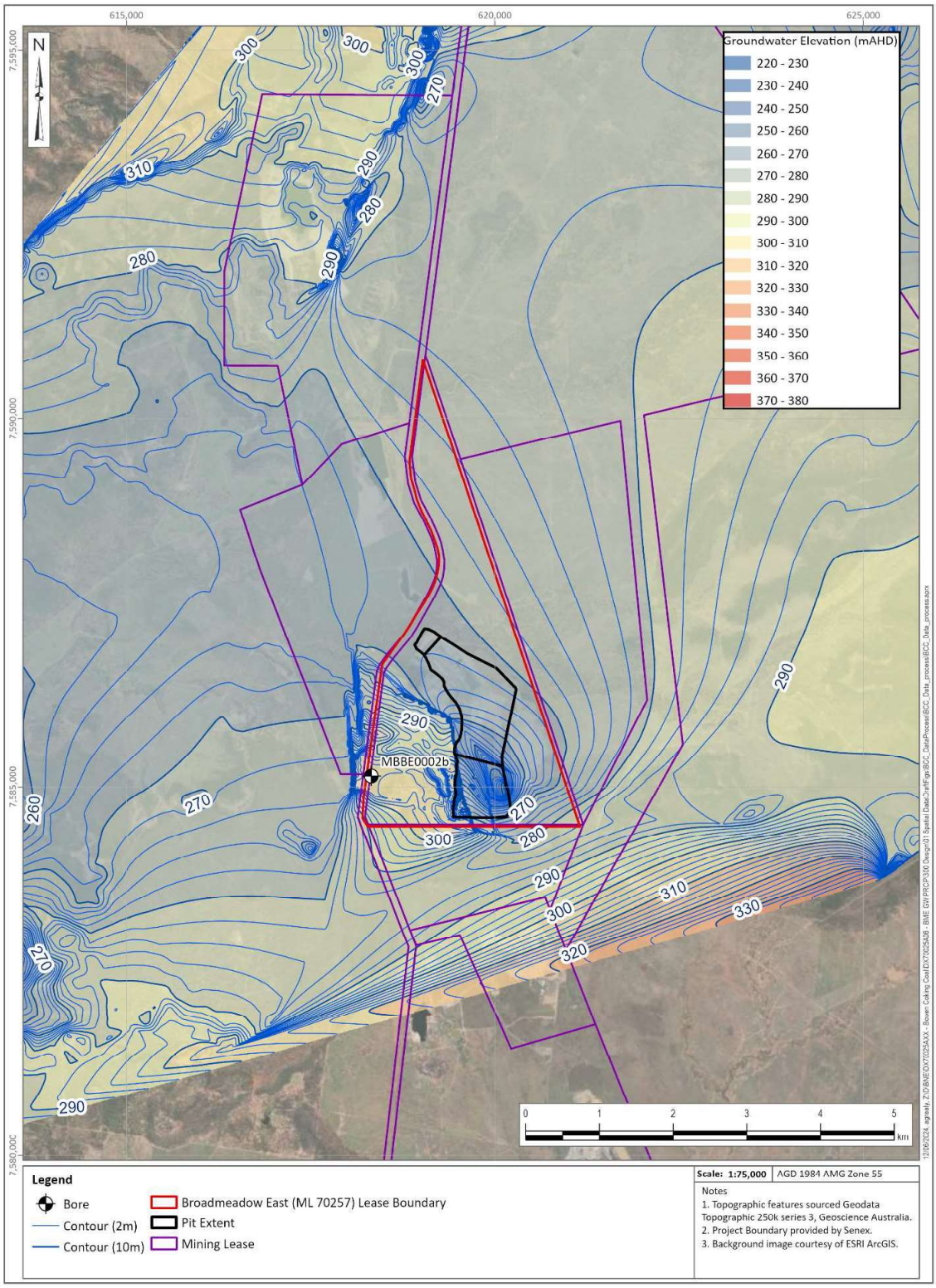


Figure 5.2 Predicted Maximum Drawdown Elevation in Layer 2 – Tertiary Sediments

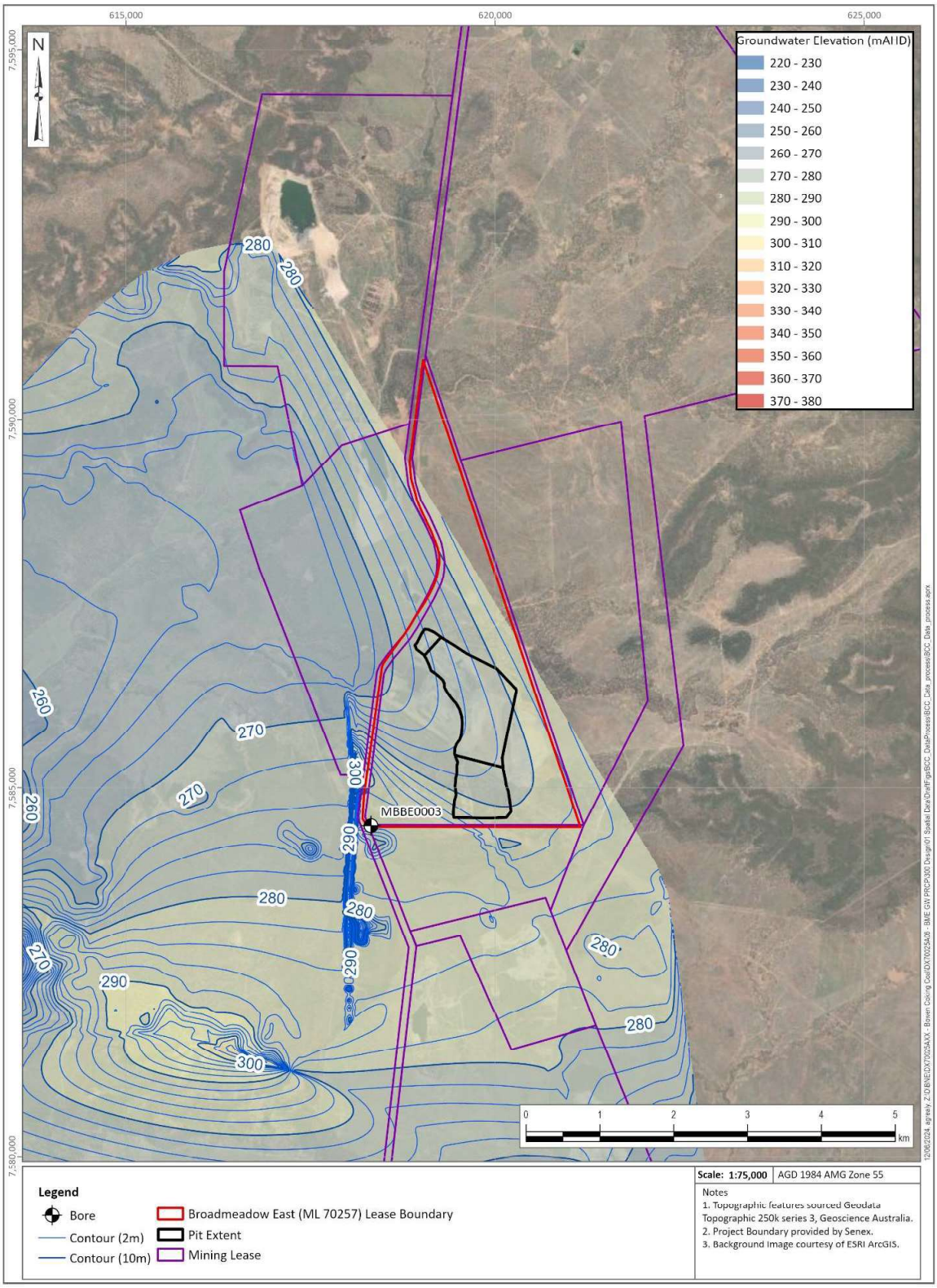


Figure 5.3 Predicted Maximum Drawdown Elevation in Layer 3 – Tertiary Basalt

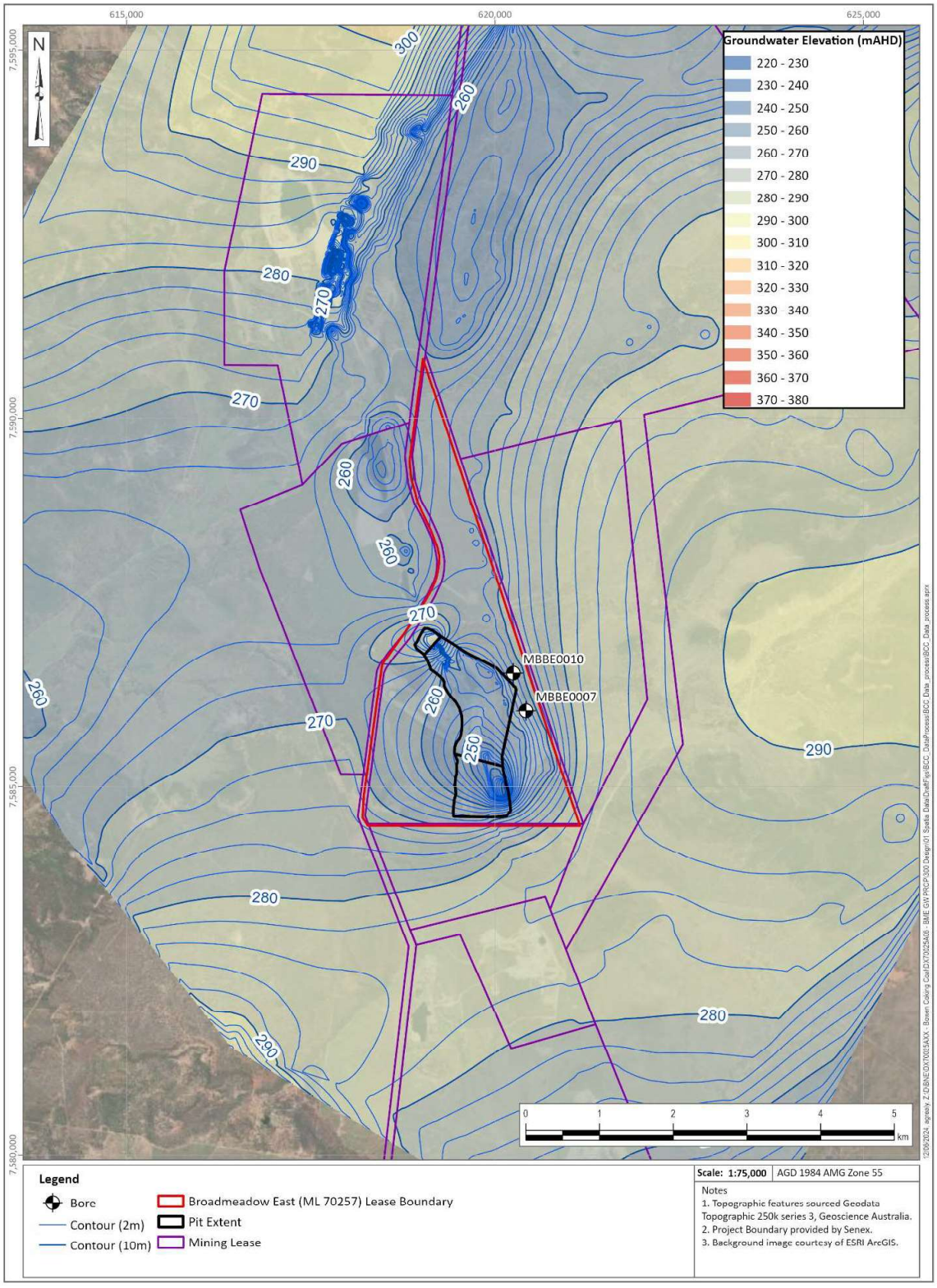


Figure 5.4 Predicted Maximum Drawdown Elevation in Layer 4 – Rewan Group

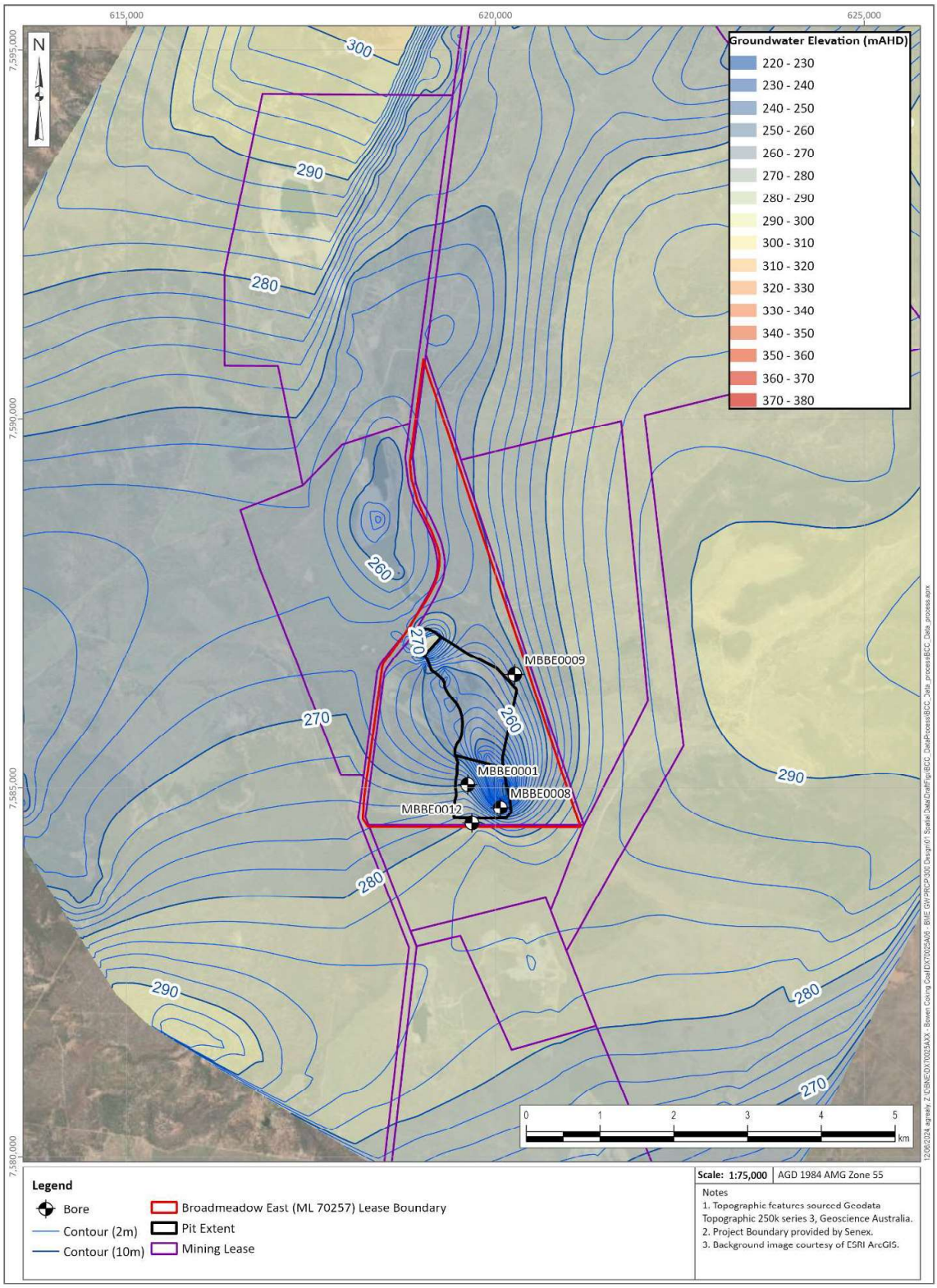


Figure 5.5 Predicted Maximum Drawdown Elevation in Layer 5 – Rangal Coal Measures

6 SUMMARY AND RECOMMENDATIONS

This technical memorandum was compiled to assist BCC in the compilation of an EA Amendment application.

The following triggers – with specific reference to compliance bores MBBE0001 and MBBE0007 - were evaluated and updated where applicable in this document:

- Groundwater quality (based on bore-specific water quality monitoring data); and
- Groundwater levels (based on model predictions of the expected changes).

MBBE0007 Summary

- The sulfate concentration shows an increasing trend from July 2023 to December 2023. The latest result shows a decline in the concentration, but the concentration still exceeds the trigger limit. The increasing trend could be due to impact from mining activities (spoil and overburden dump leachate).
- The 2021 DES guideline states "*The time series data should also be analysed for trends. If a trend, either upward or downward, is detected then the groundwater may be impacted. In general, data with values increasing over time should not be used to calculate site-specific groundwater guidelines".*
- An increasing trend in the data may indicate contamination of the groundwater and should be investigated. The latest monitoring event in February 2024 shows a decline in the EC concentration.
- An update for the water quality trigger limit considered 10 of the 13 available data points; excluding two outliers and the most recent data result that seems to be influenced by high rainfall events.
- Arsenic, aluminium and selenium have less than 8 data points available for trigger calculation. All three analytes have a very large part (76 to 92%) of their dataset values reported as below Limit of Reporting.

MBBE0007 Recommendations

- Update the sulfate (SO_4) water quality trigger limit to 961.5 mg/L.
- Update the electrical conductivity (EC) water quality trigger limit to 48,600 µS/cm.
- Update aluminium, arsenic and selenium water quality triggers to reflect the default water quality guideline values.

MBBE0001 Summary

- The electrical conductivity concentrations have exceeded the trigger limit of the total monitoring period. These limits were originally calculated on only a few data points, but additional data points have since become available to include in the statistical calculations.
- Sulfate, arsenic, molybdenum and selenium have less than 8 data points available for trigger calculation. All three analytes have a very large part (56 to 10%) of their dataset values reported as below Limit of Reporting.

MBBE0001 Recommendations

- Adjust the electrical conductivity (EC) quality trigger to 901.7 µS/cm, based on the additional chemistry results that are available since previous trigger calculations.
- Update sulfate (SO_4), arsenic, molybdenum and selenium water quality triggers to reflect the default water quality guideline values.

New Monitoring Bores

Additional monitoring bores were drilled in October 2023 to update the existing network after some EA monitoring bores were decommissioned as a result of the progression of approved mining activities.

The following are the main recommendations for these new replacement bores:

- Water Quality sampling at the newly drilled 2023 bores should initially be done at a bi- monthly frequency.
- Once sufficient water quality data is available (minimum 8 sampling events within one full calendar year of data), triggers should be set for the new 2023 bores.
- Default Water Quality Guideline values (ANZECC & ARMCANZ, 2000) should be used as temporary groundwater quality trigger parameters for MBBE0009. The parameters pH, EC, SO_4, Al, As, Se, Mo are recommended as appropriate triggers for the contaminants of concern for coal mining operations (see summary in Table 5.1). Data analysis results for two (2) sampling events at MBBE0009 differ substantially from MBBE0001 and therefore it is not recommended that trigger limits are inferred, even though the two bores are screened in the same aquifer.
- The groundwater model should be verified and potentially updated with the new bore drilling and data collection.
- Bore MBBE0011 cannot be assigned a pre-mining baseline standing water level, since no groundwater was encountered, and the bore is considered dry. This approach has also been followed in the previous Amendment of EA0002465.

New Monitoring Bore Recommendations

- Groundwater levels trigger values for all four replacement bores are recommended based on the maximum drawdown predicted from the numerical groundwater model (KCB 2023).
- Default WQO guideline values (ANZECC & ARMCANZ, 2000) should be assigned to MBBE0009 (future compliance bore) as temporary groundwater quality triggers, until at least eight (8) sampling event results are available. Then bore-specific triggers should be calculated for the four bores.

The recommended trigger values should be applicable through operation into post-closure. An update of the trigger levels for both quality and water level will be required once sufficient data points (minimum of 8) become available.

7 CLOSING

This memorandum is an instrument of service of Klohn Crippen Berger (KCB). The memorandum has been prepared for the use of Bowen Coking Coal (Client) for the specific application to the Broadmeadows East Project and may be published or disclosed by the Client to the Department of Environment, Science and Innovation.

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KCB AUSTRALIA PTY LTD.



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MN:CW:JJ

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ENGENY

BOWEN COKING COAL

Broadmeadow East Mine PRCP

Rehabilitation Flood Assessment

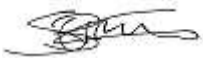
QC1015_005-REP-001-1

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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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.

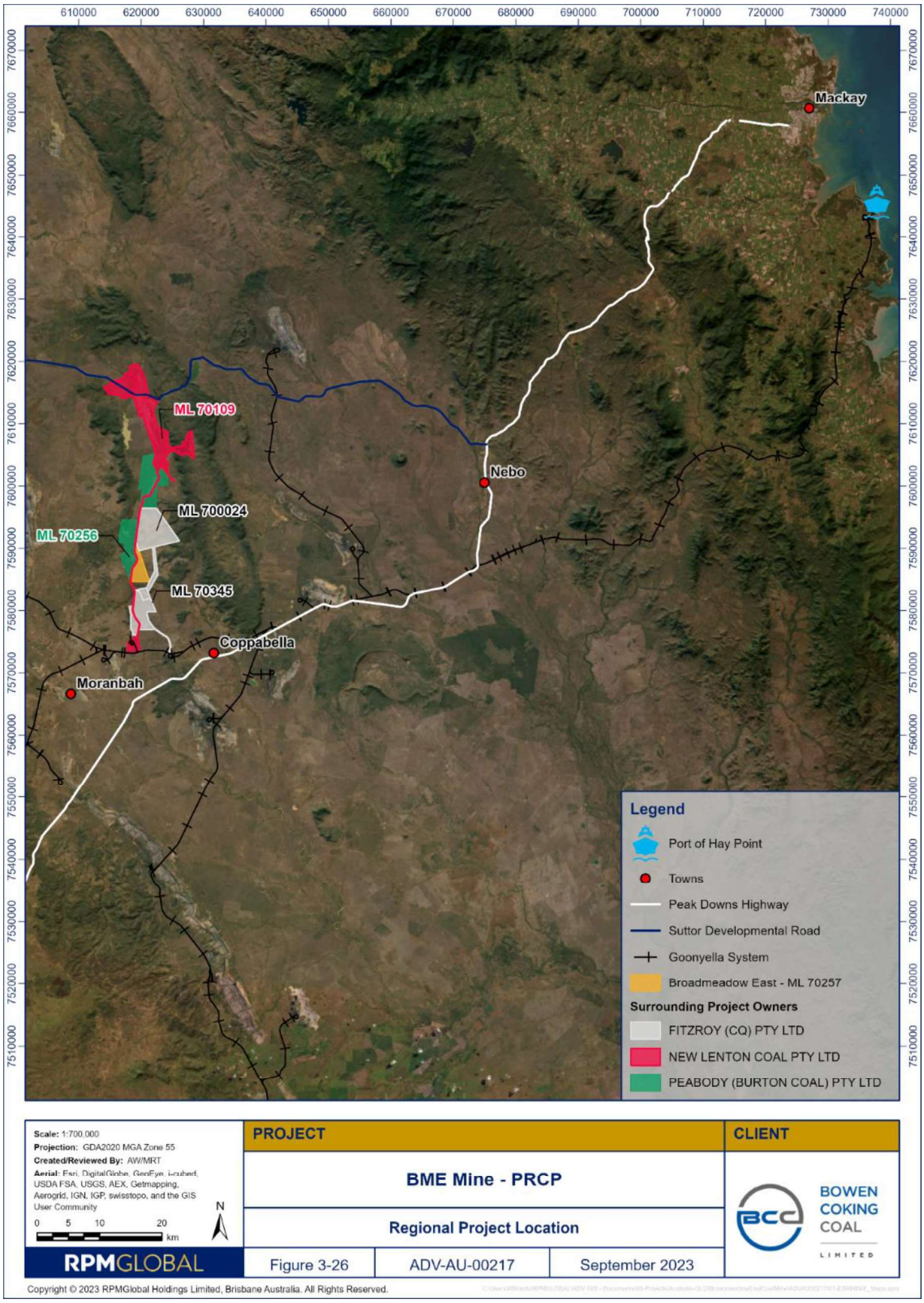


Figure 2.1: Site Location

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.

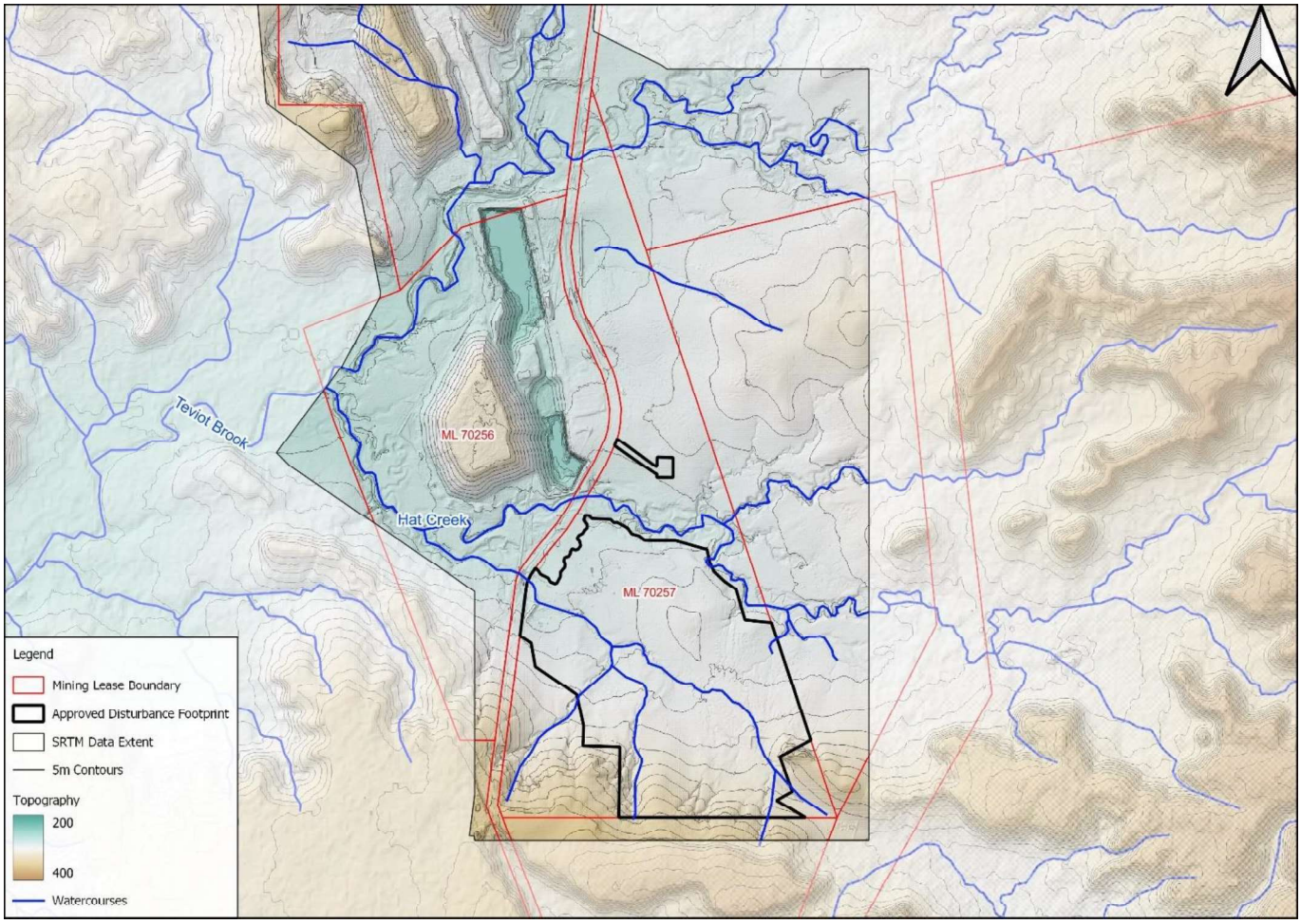


Figure 2.2: Existing Site Topography

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 (~35ha) 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.

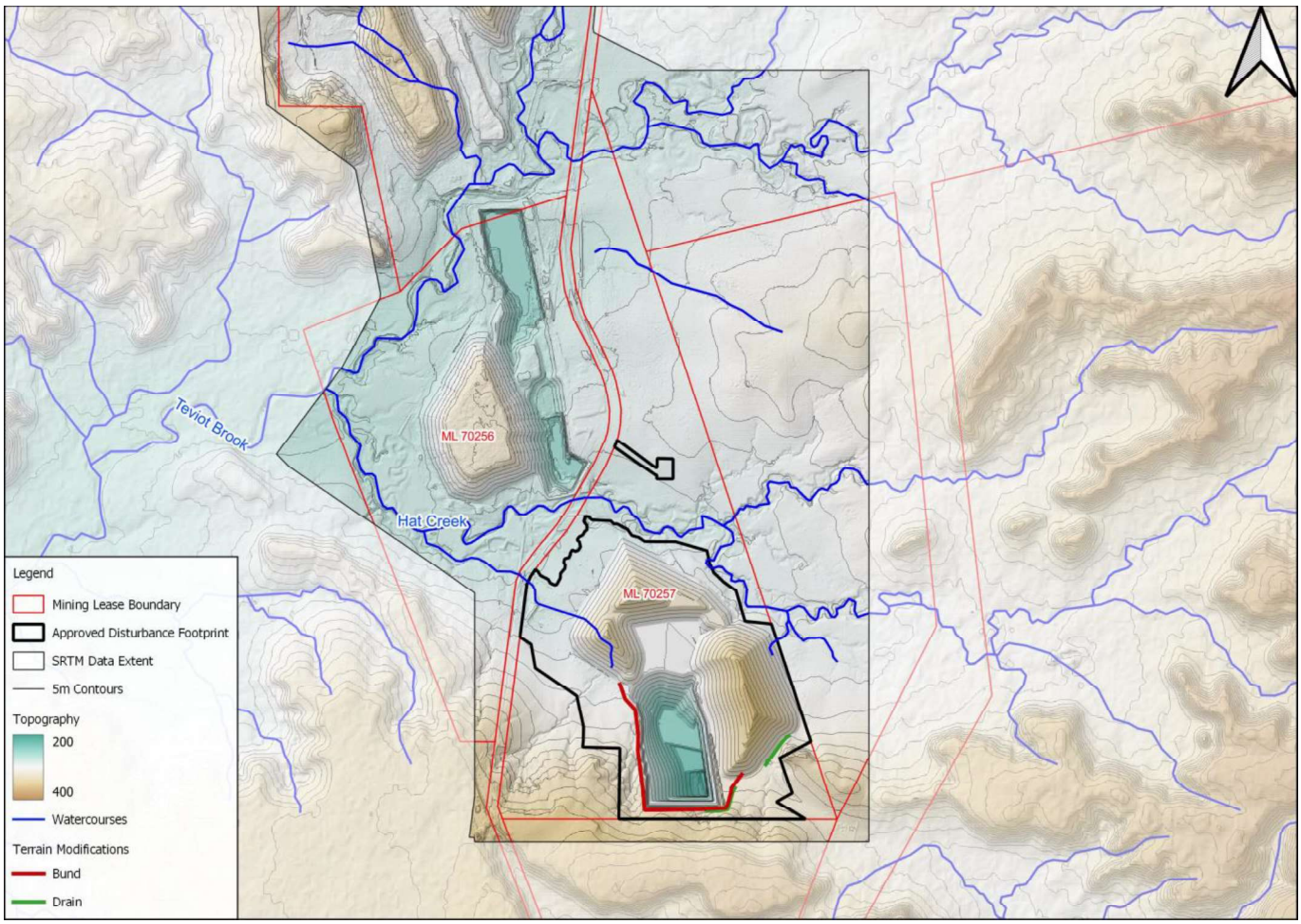


Figure 2.3: Final Landform Design

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.

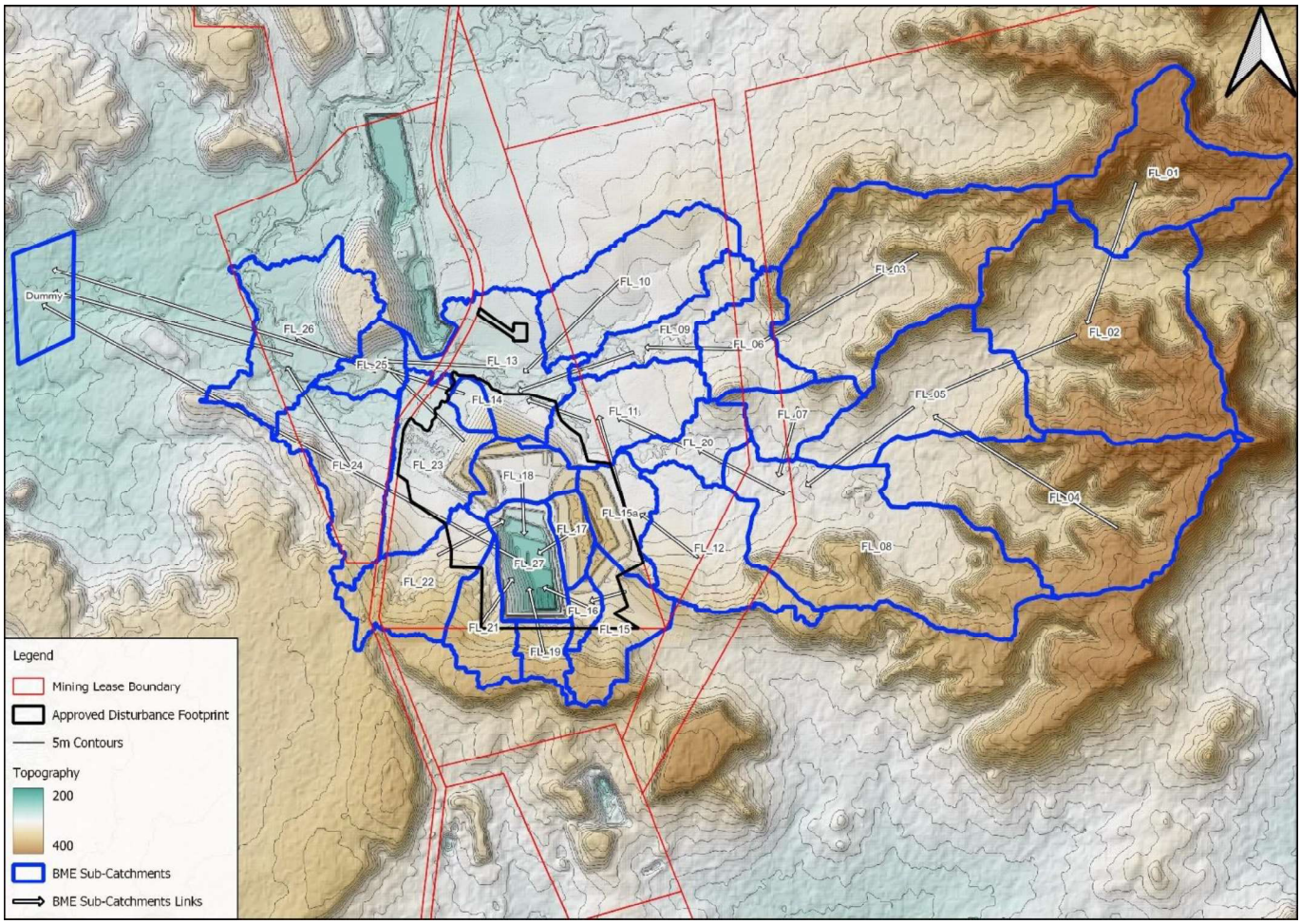


Figure 3.1: BME WBNM Sub-Catchments

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

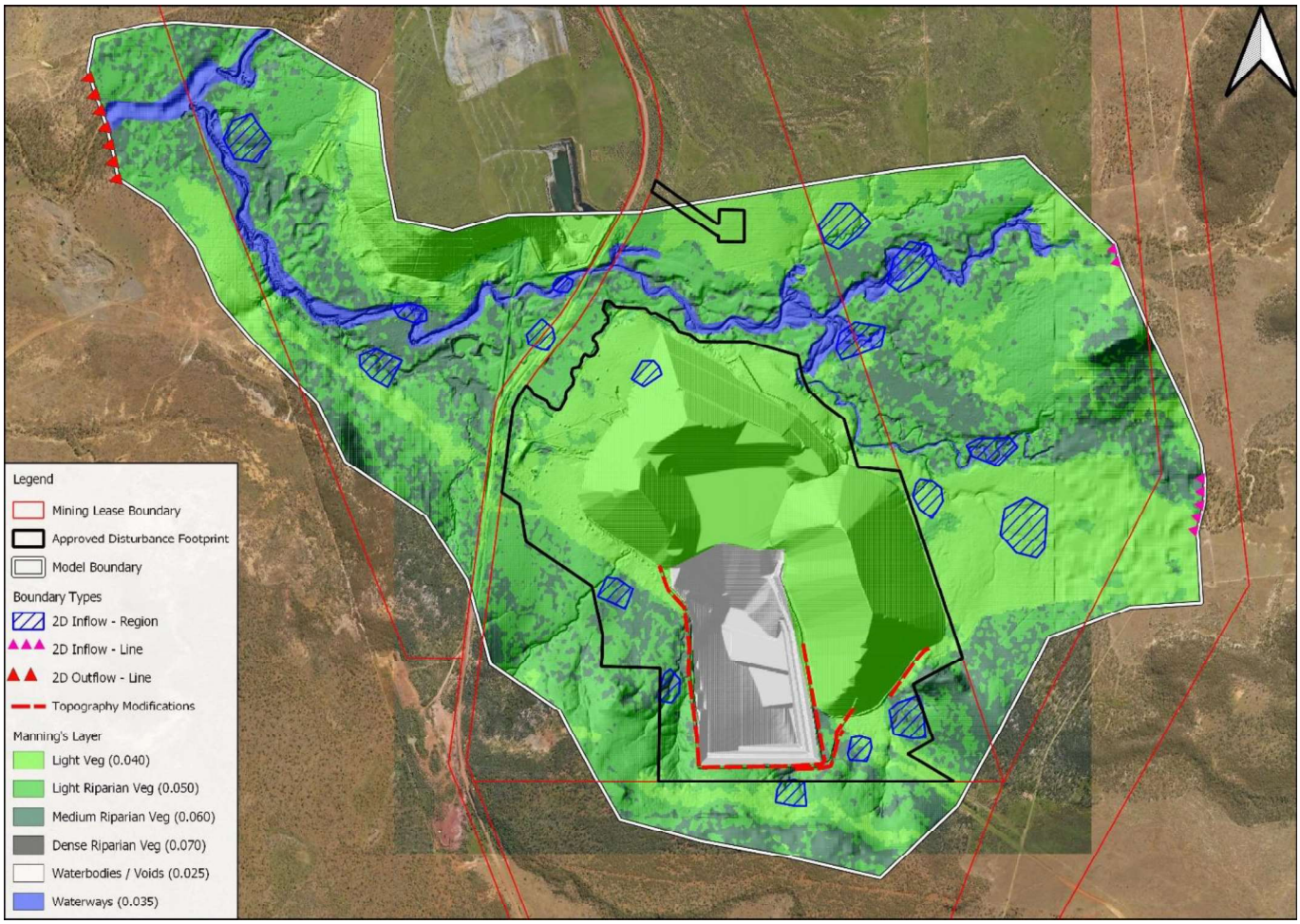


Figure 4.1: BME Final Landform TUFLOW Build

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

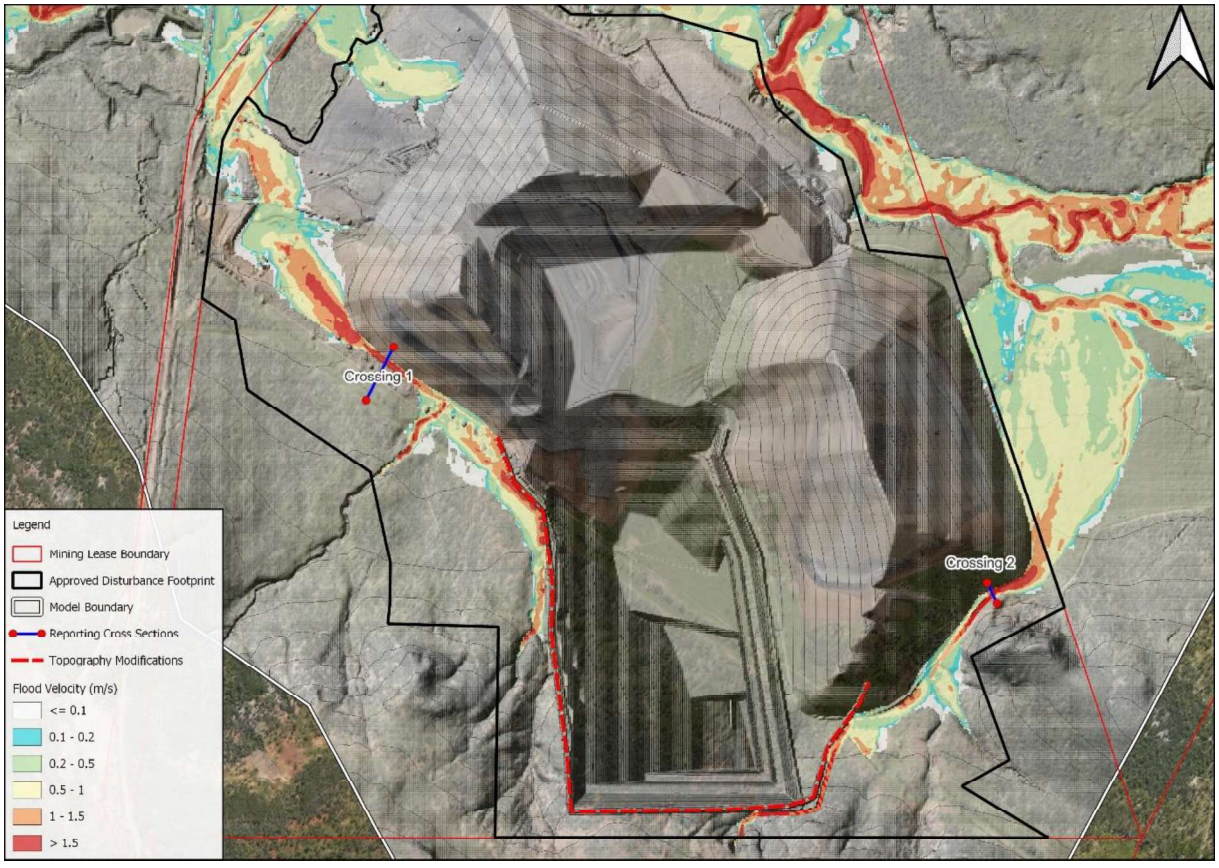


Figure 5.2: 0.1pct Flood Velocity Around Final Landform

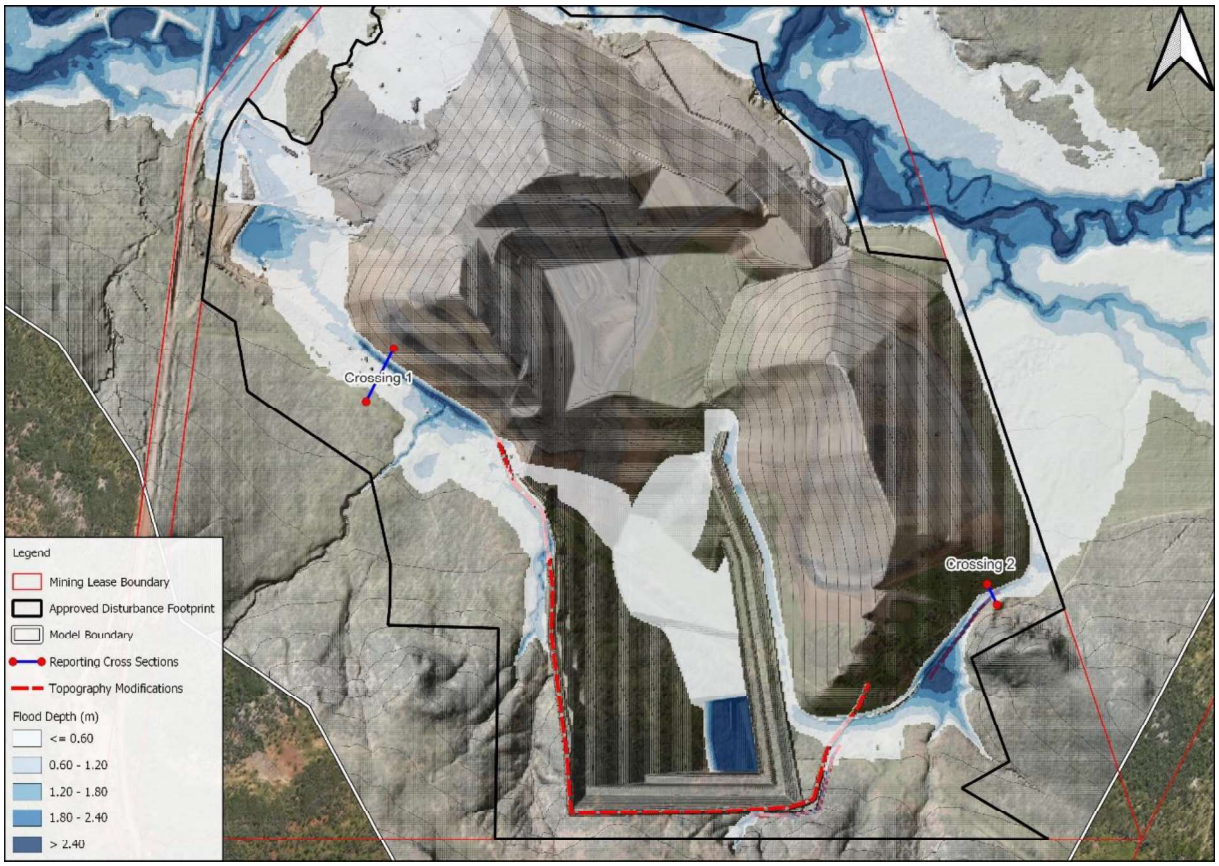


Figure 5.3: PMF Flood Depth Around Final Landform

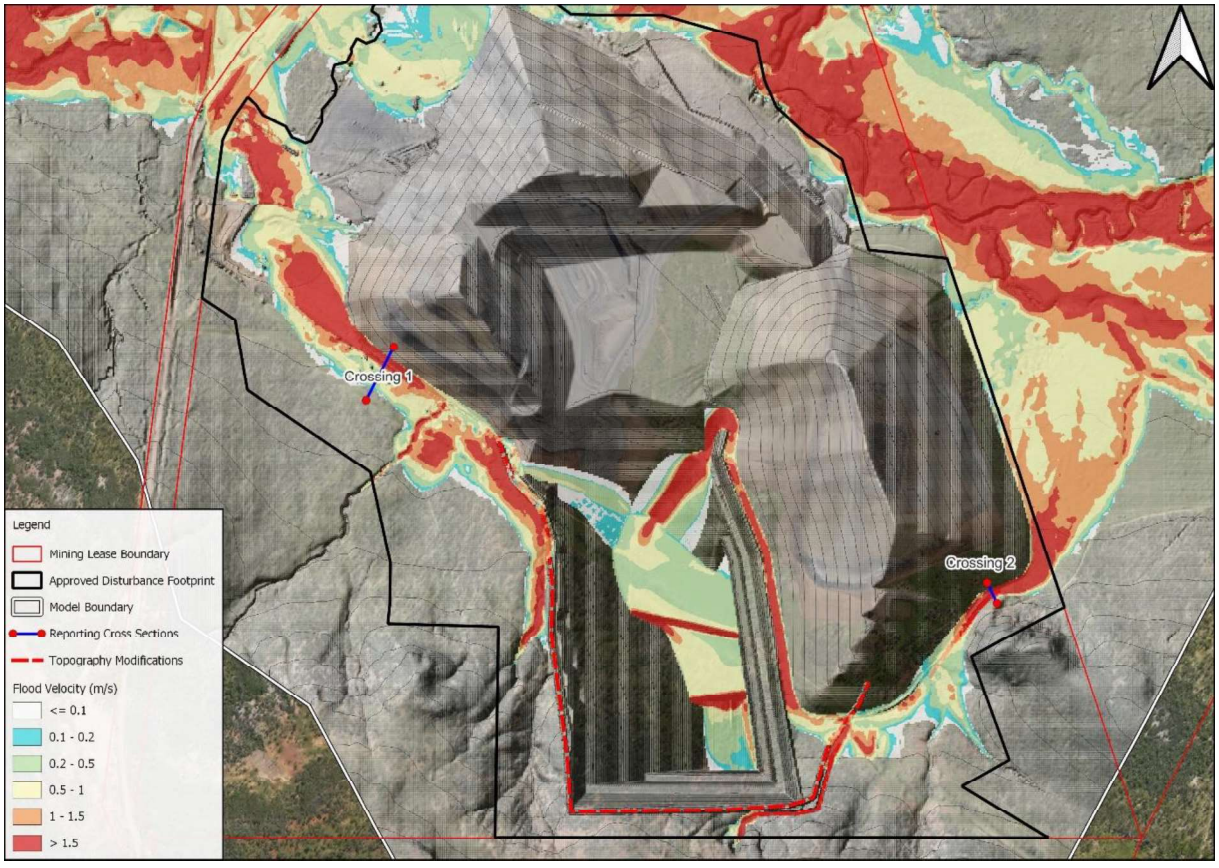


Figure 5.4: PMF Flood Velocity Around Final Landform

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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  (i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or

  (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

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(e) This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this Report.

(f) If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the Report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.

(g) This Report does not provide legal advice.

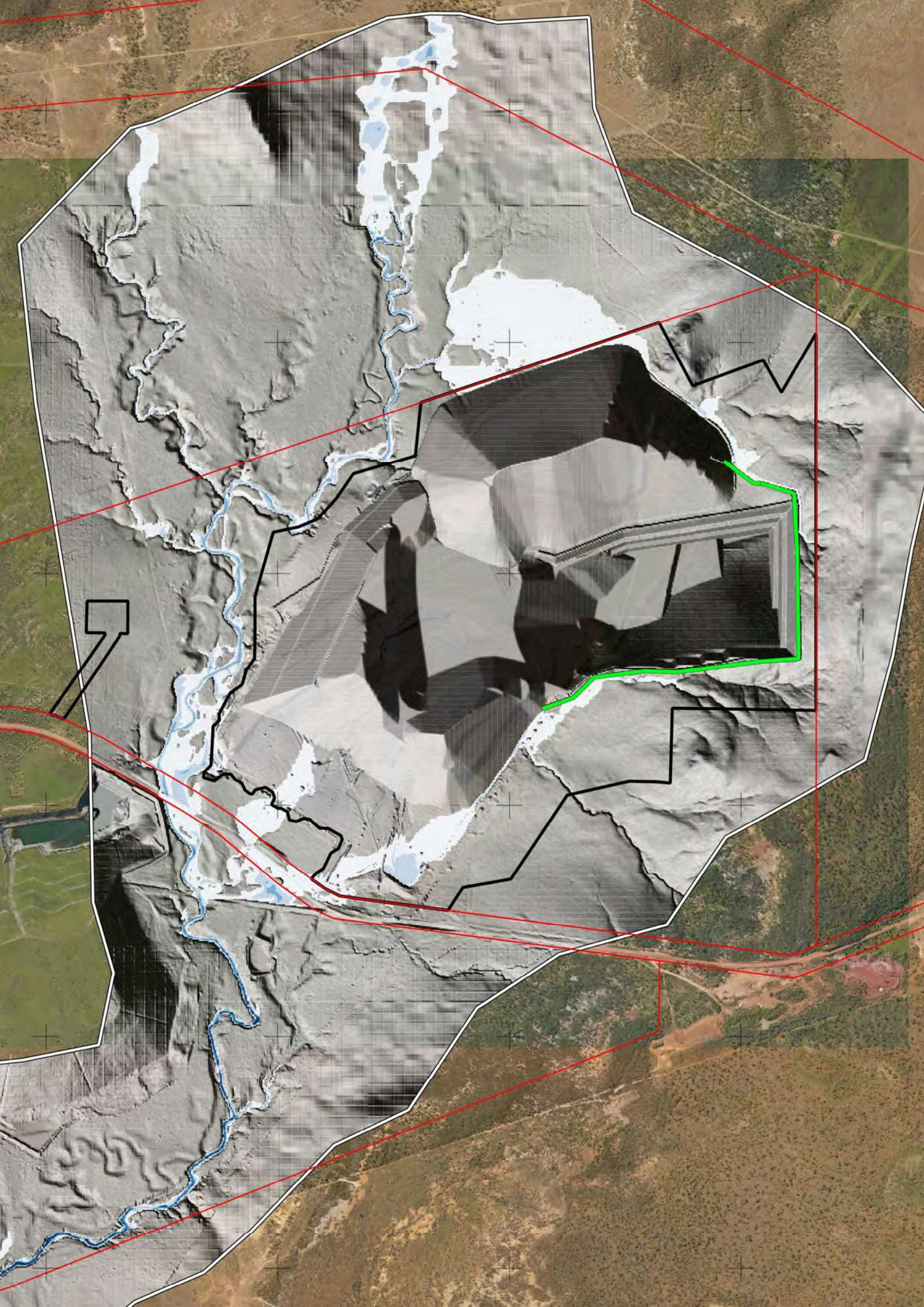
7. REFERENCES

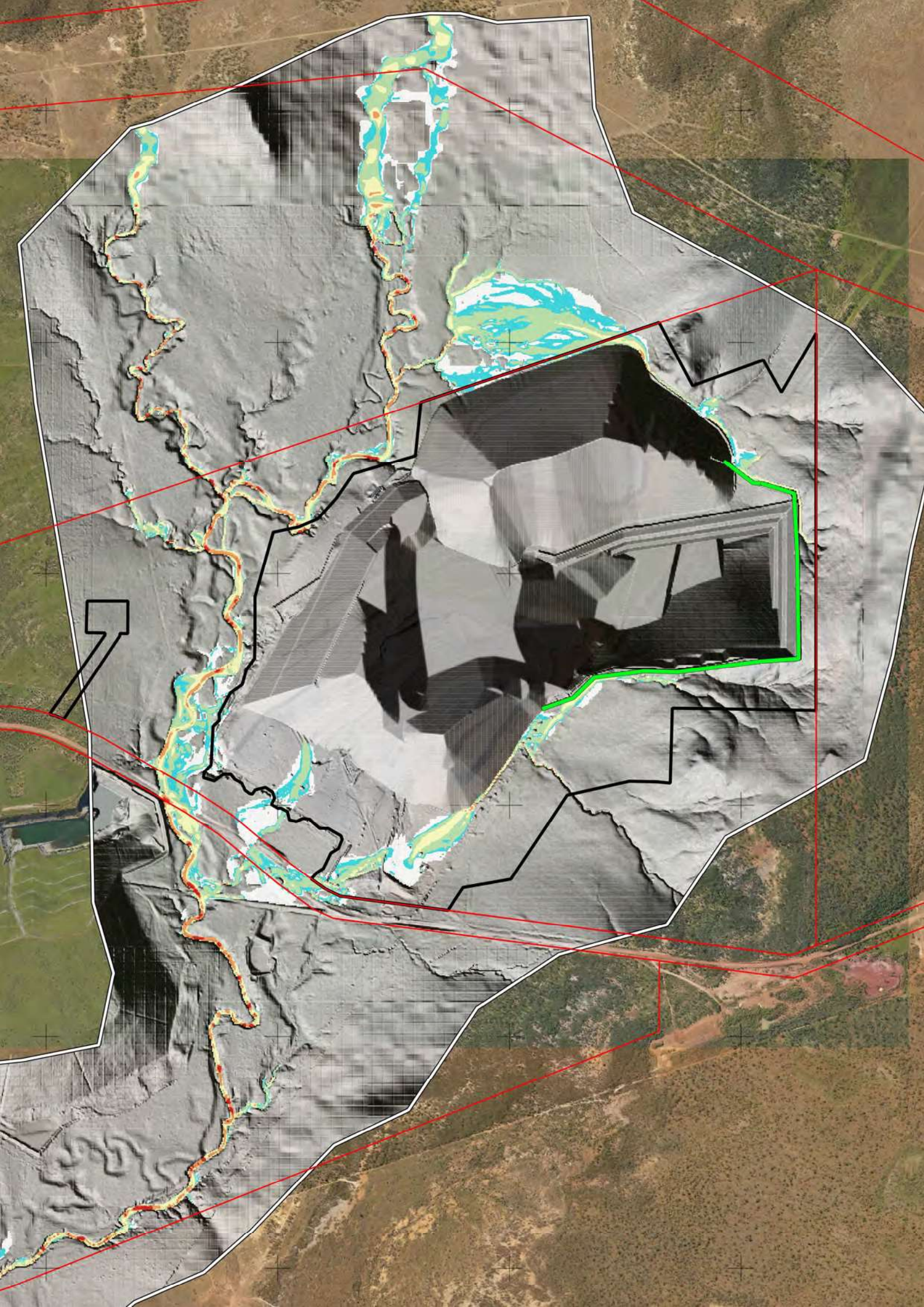
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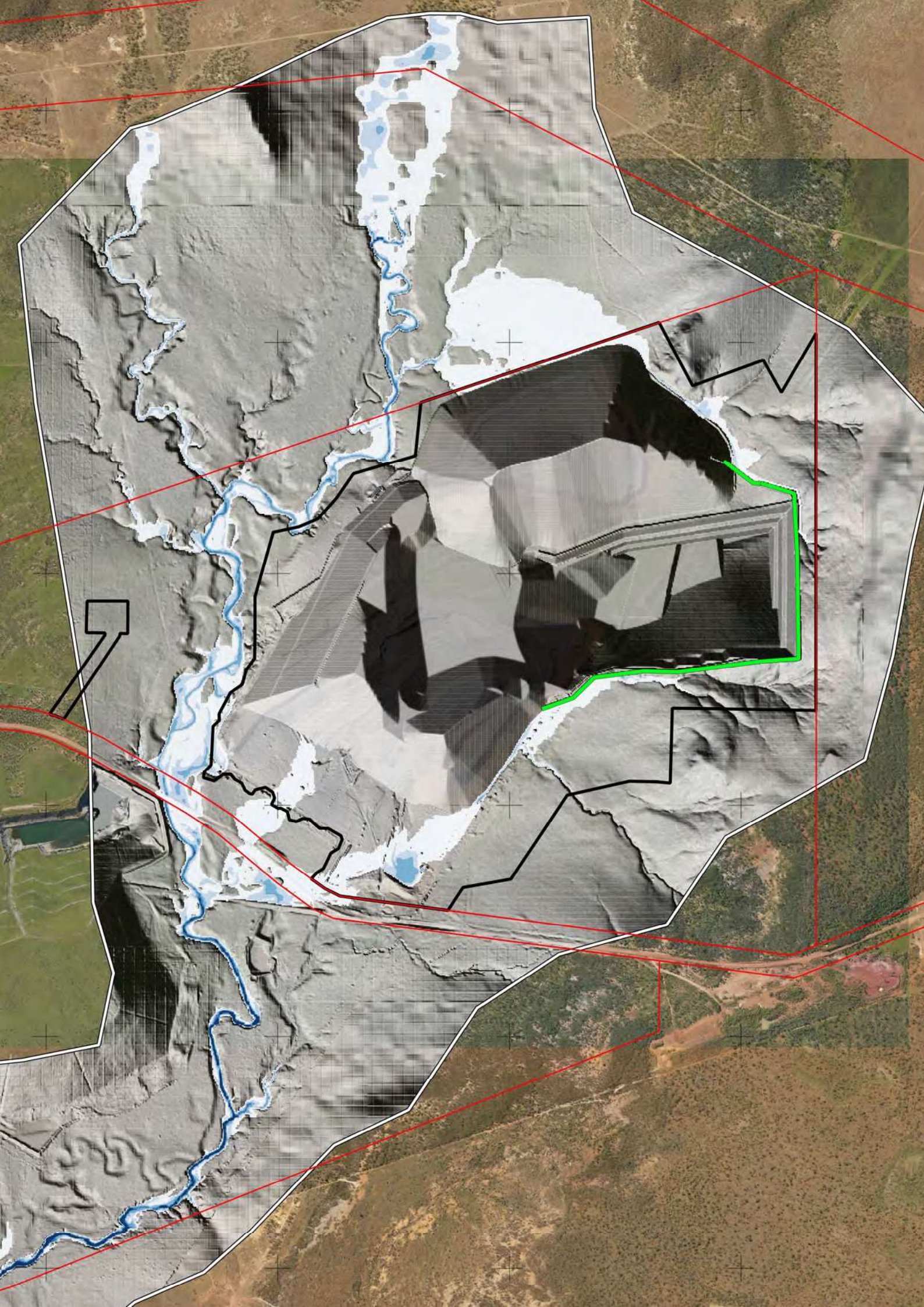
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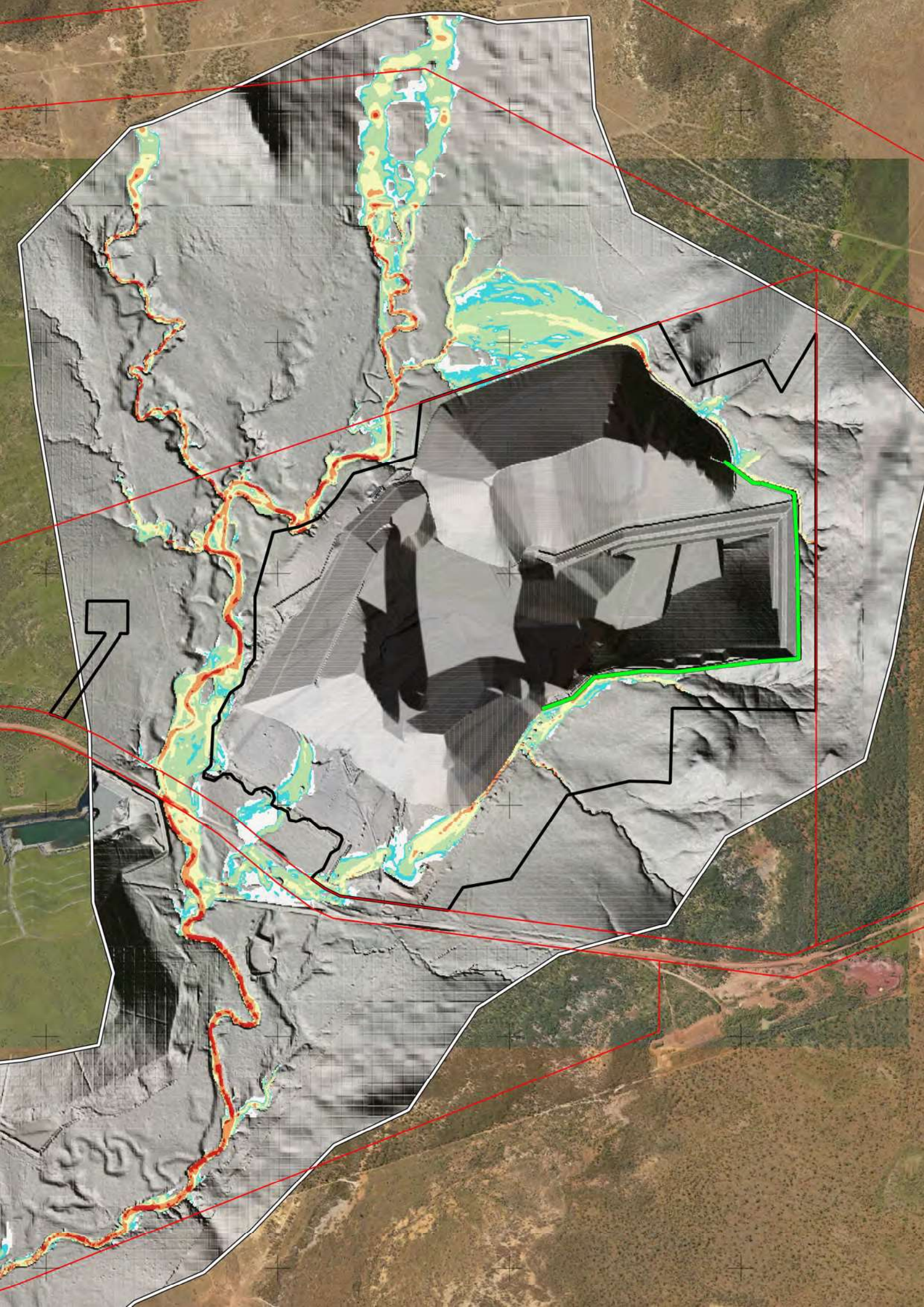
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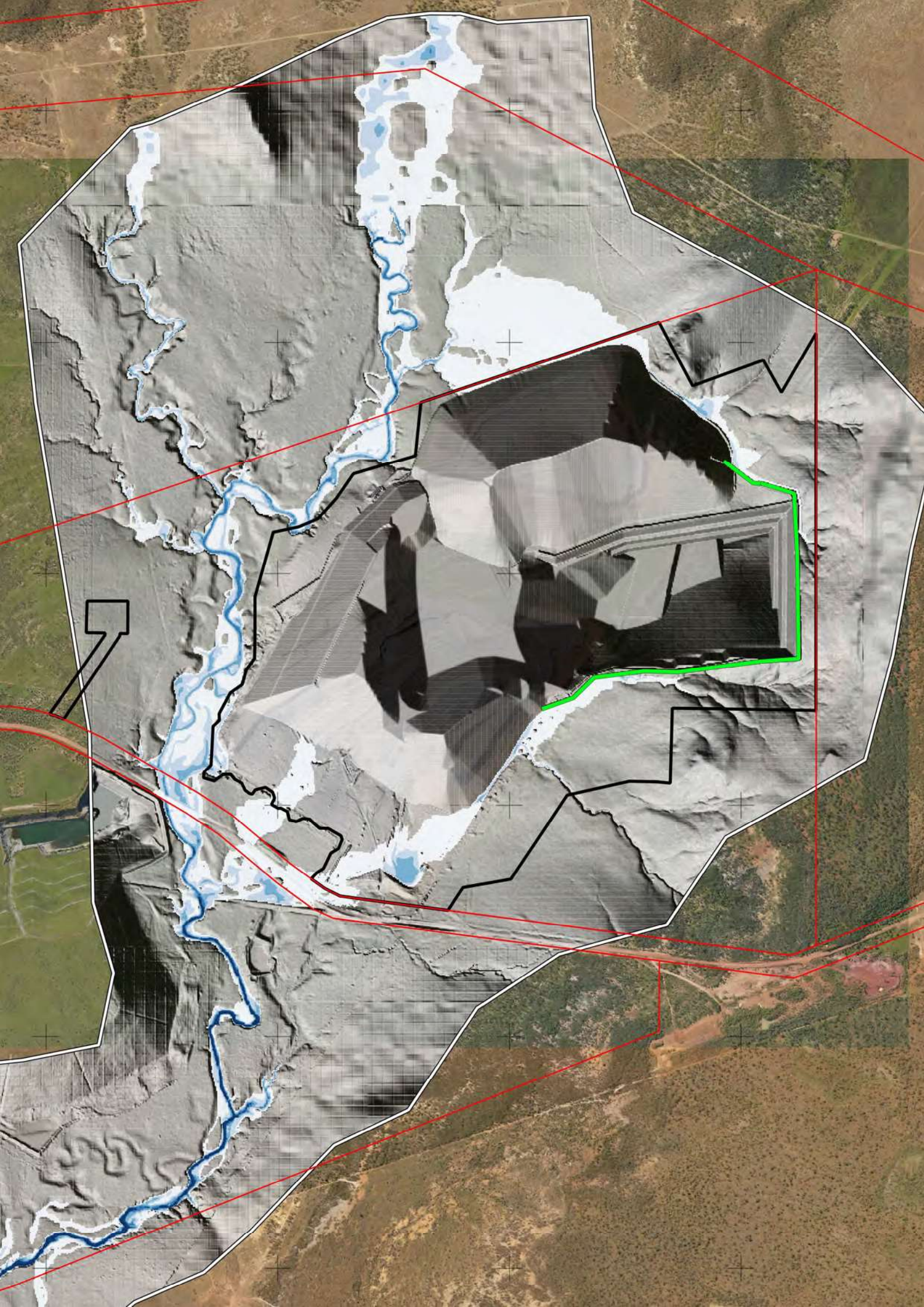
APPENDIX A: DESIGN FLOOD EVENTS

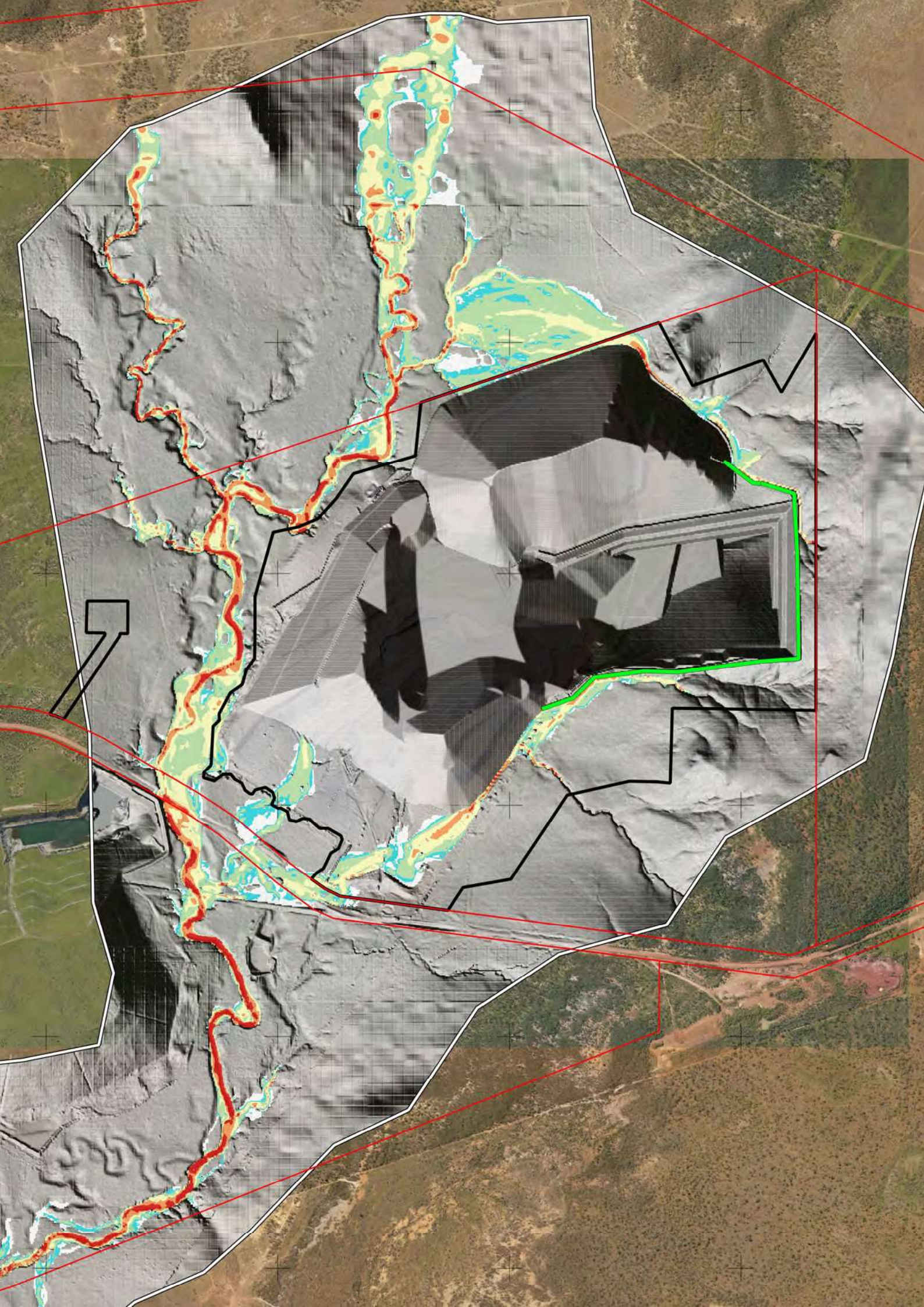


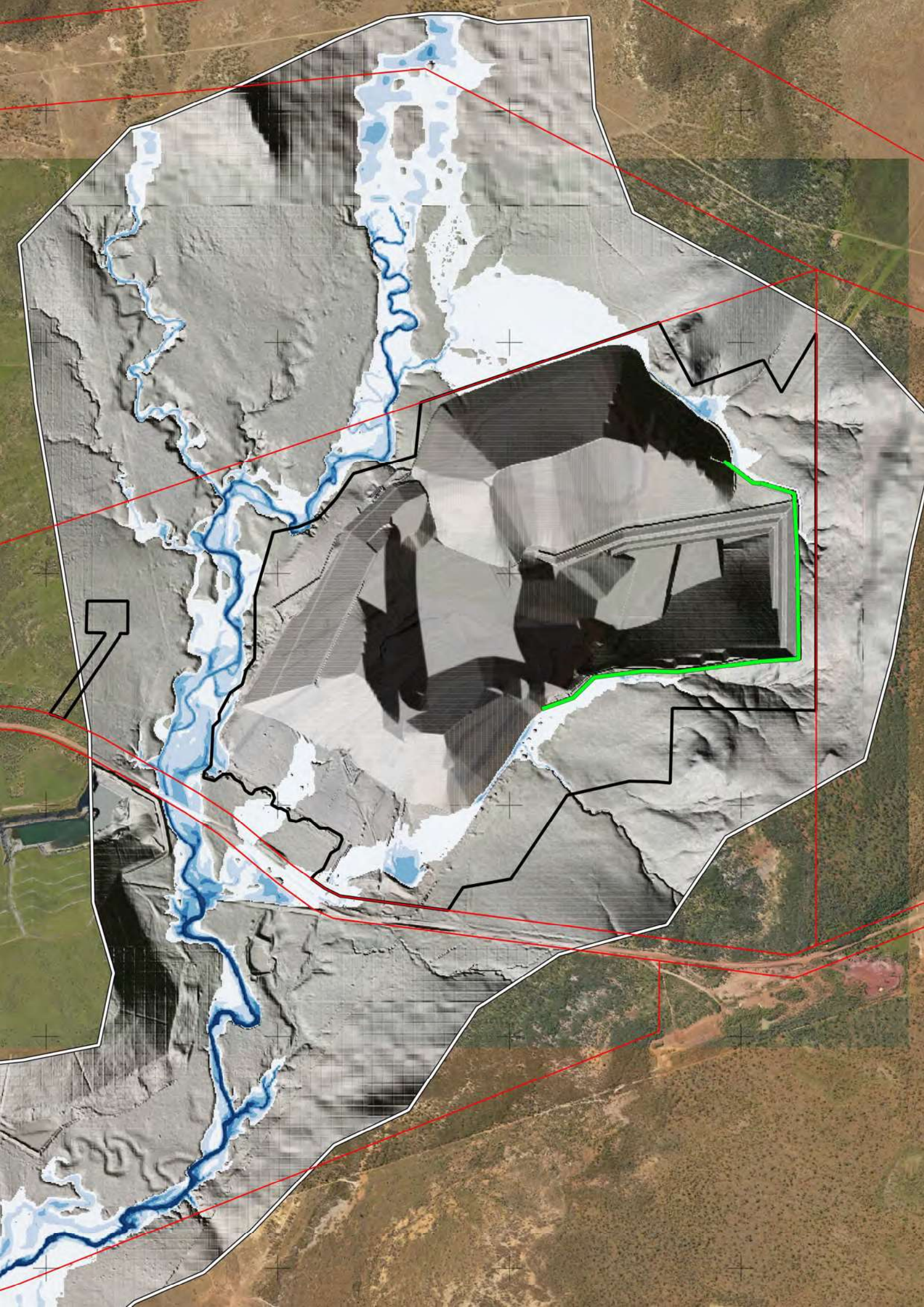


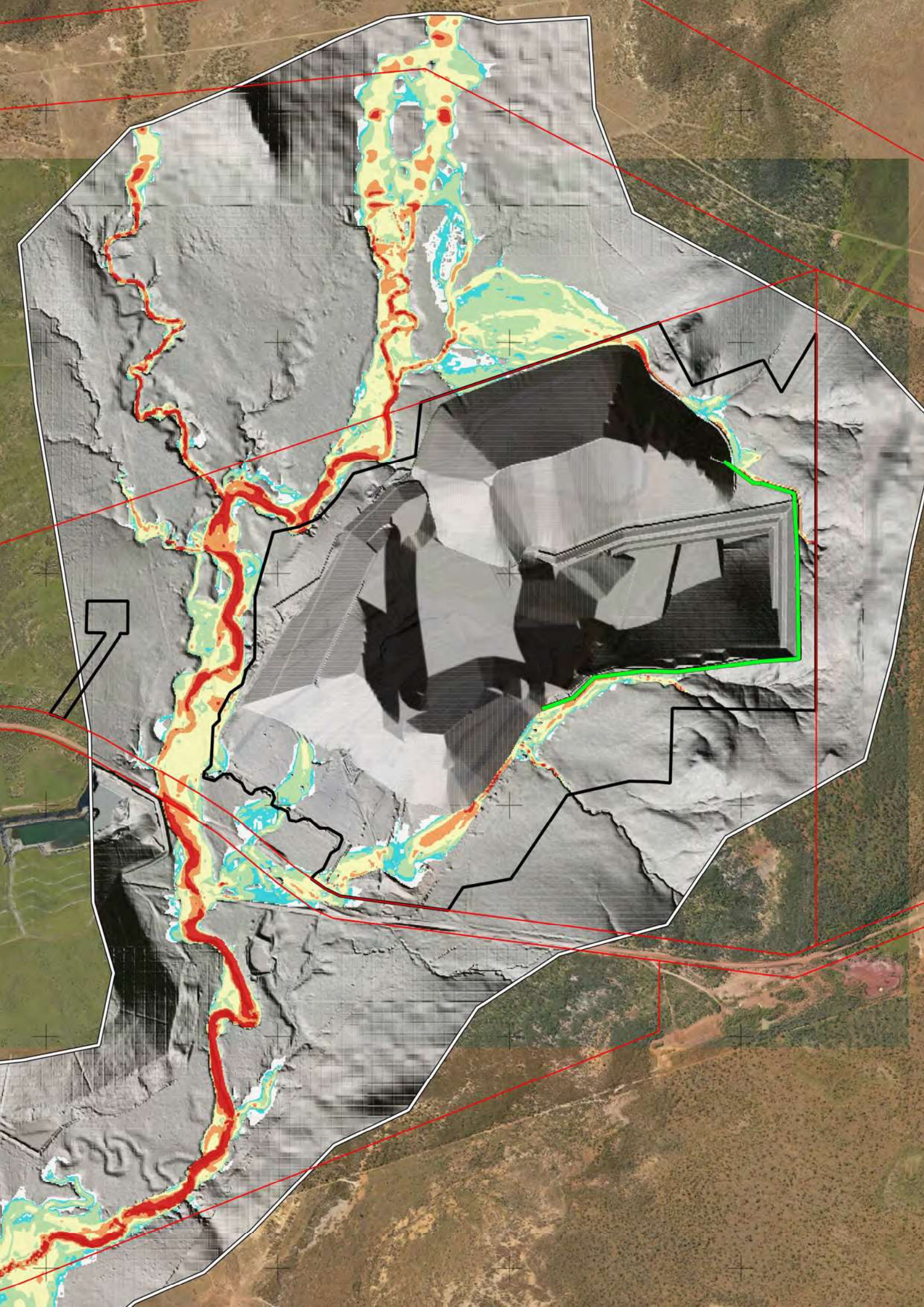


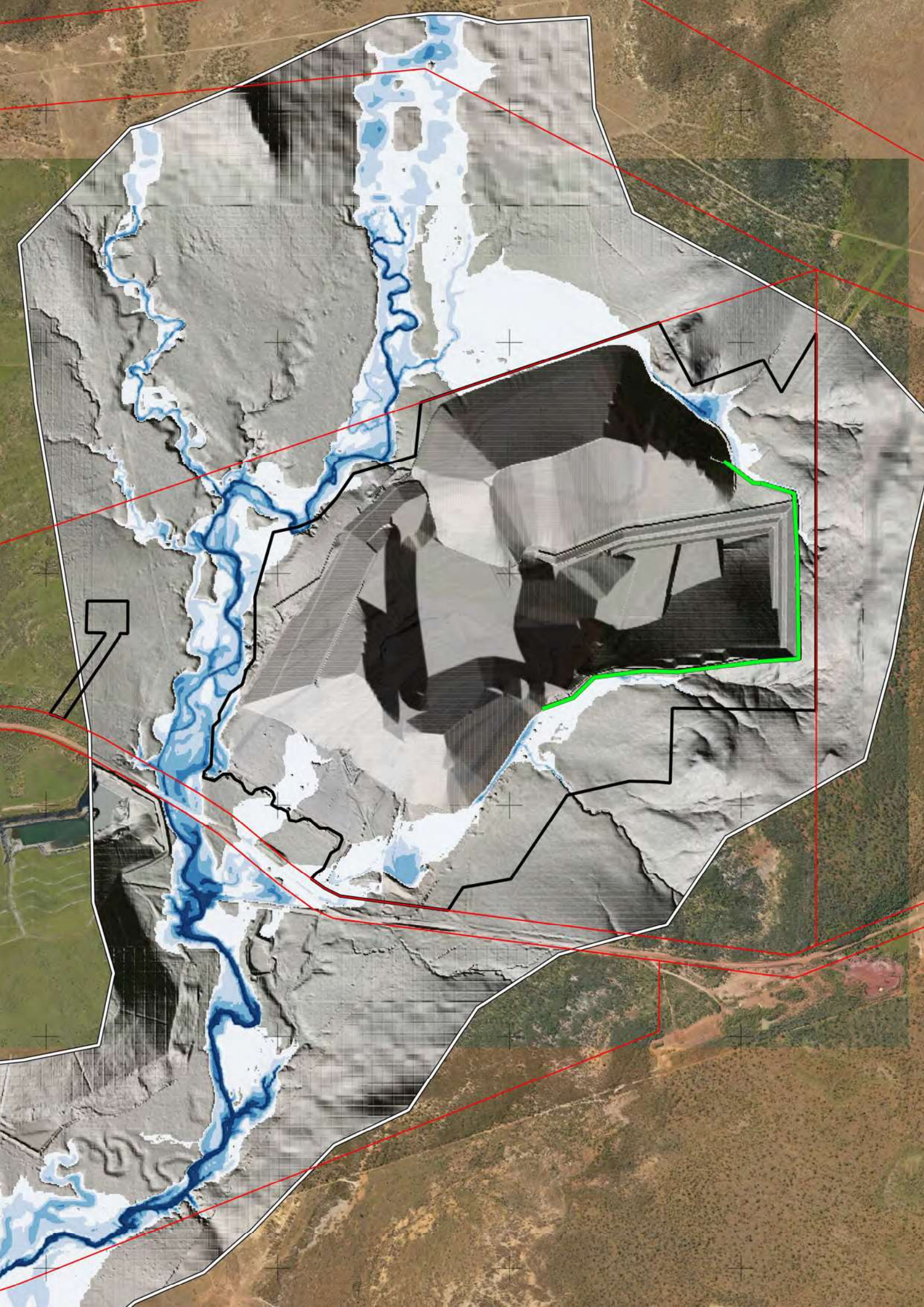


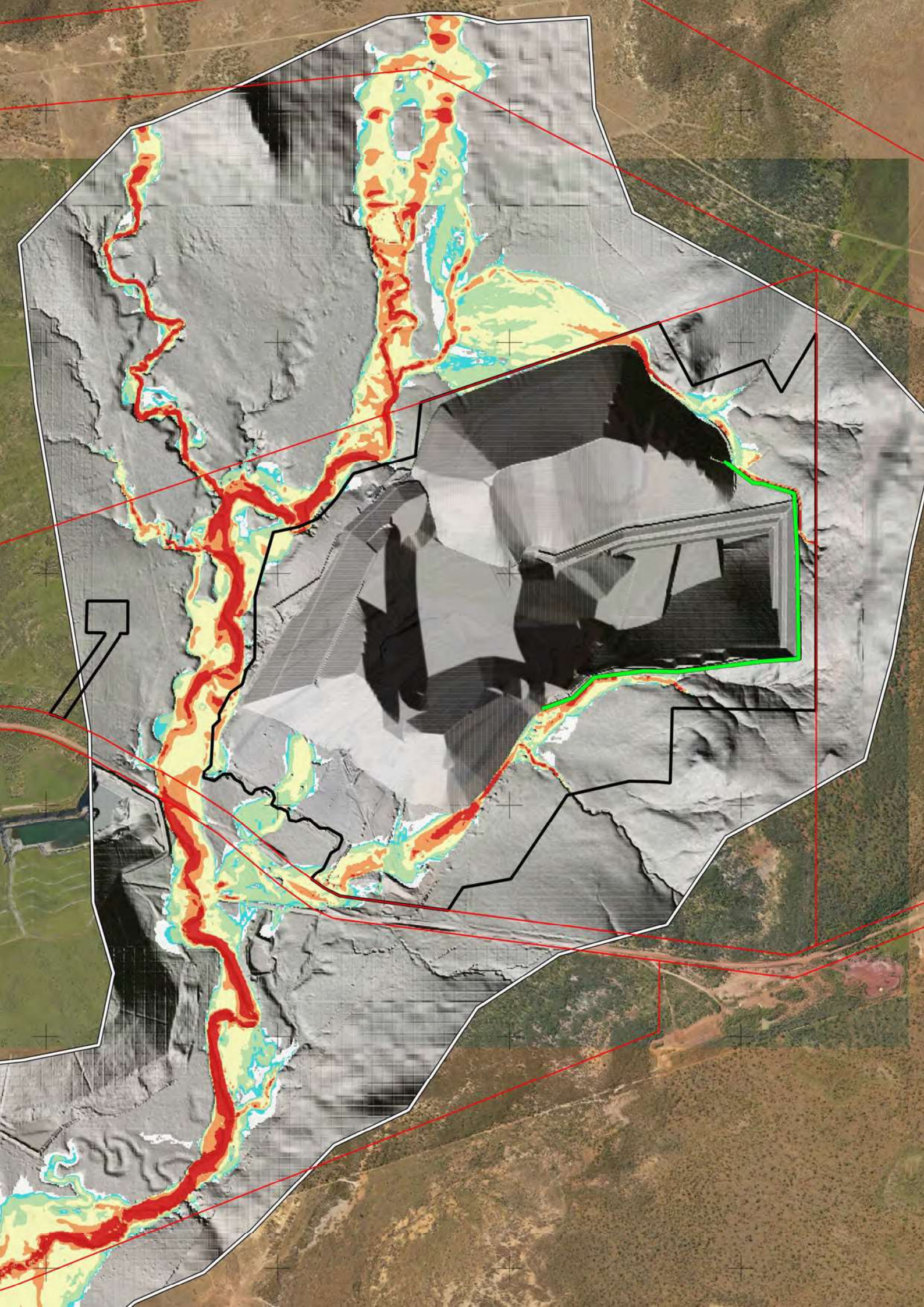


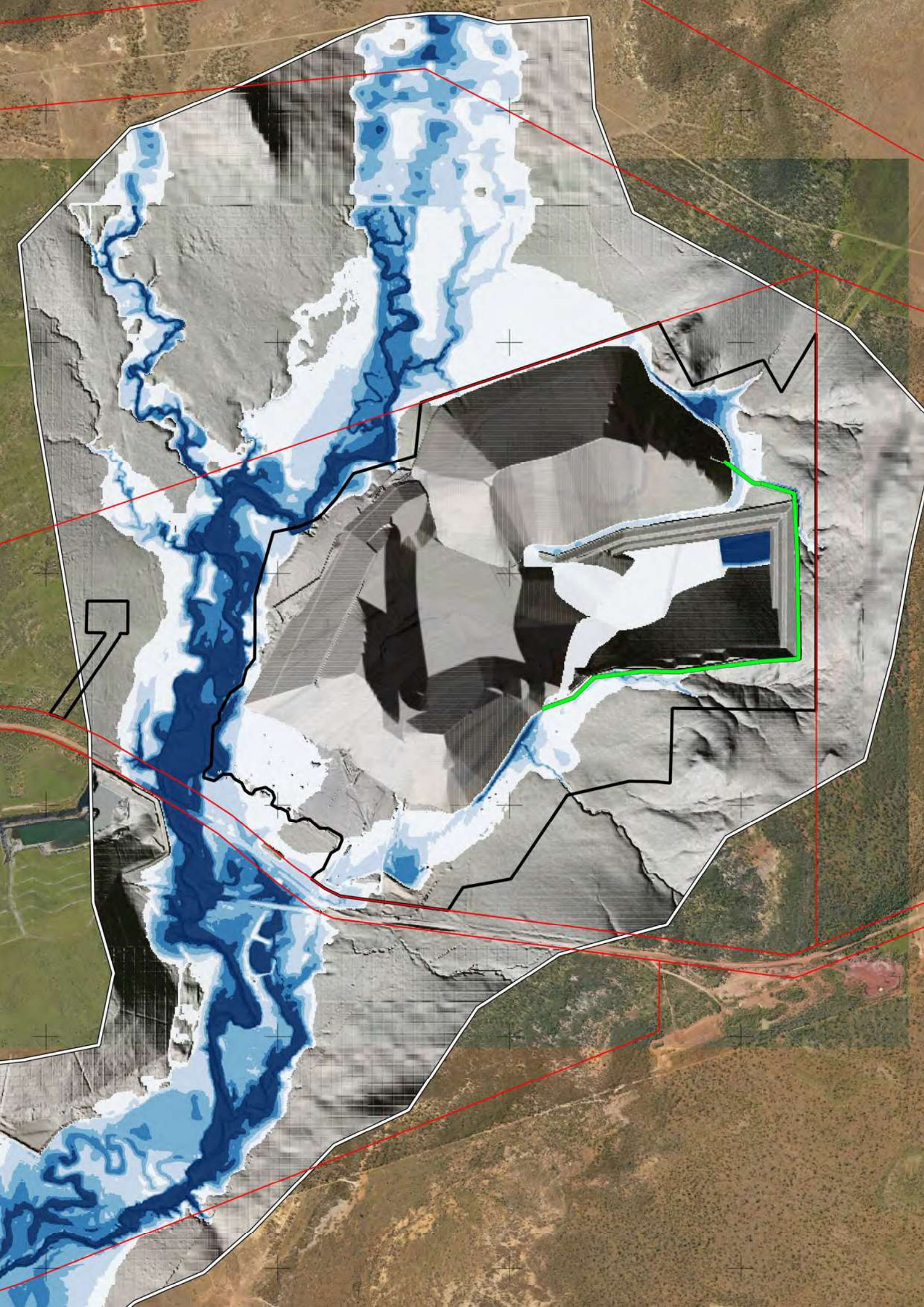


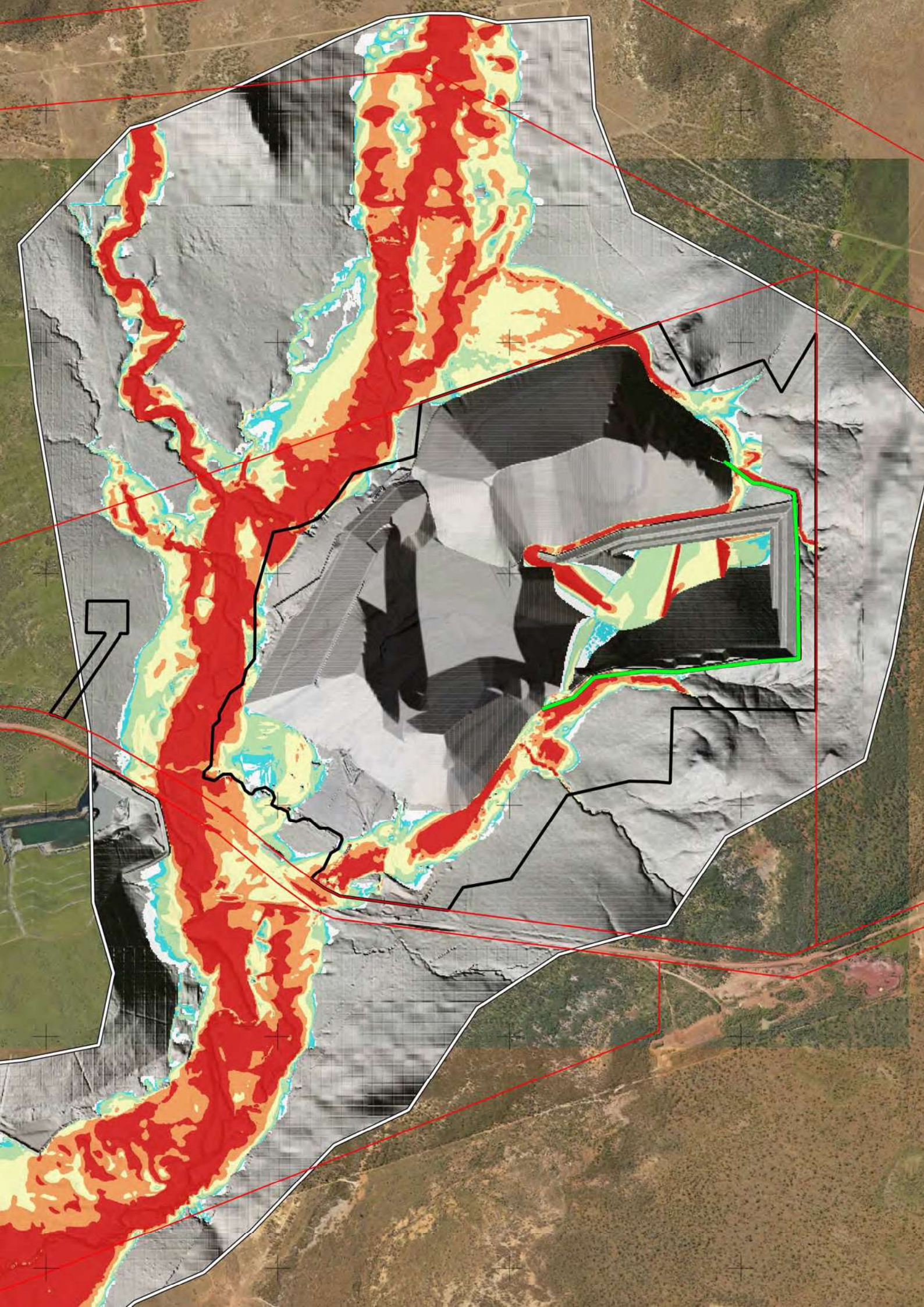




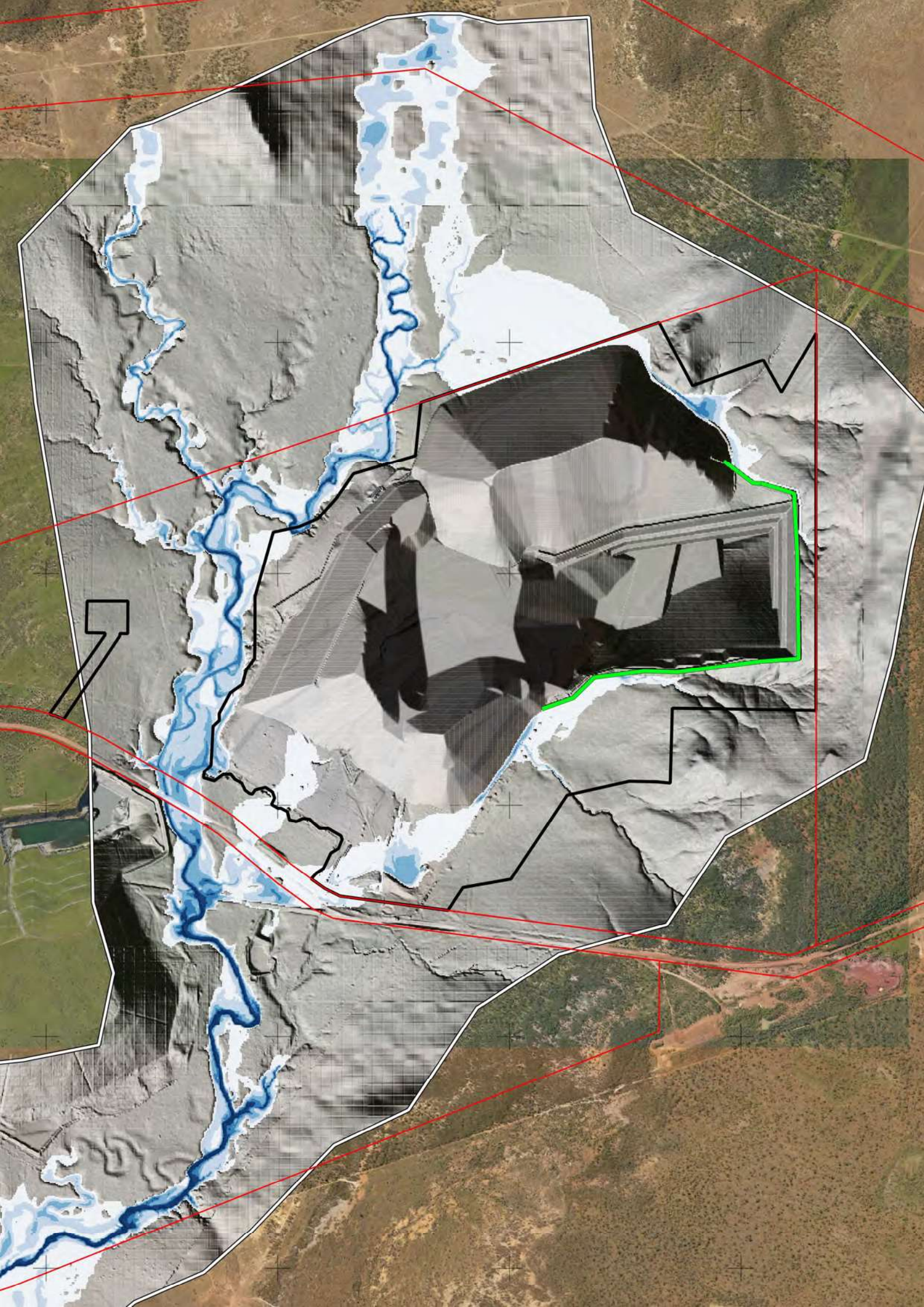


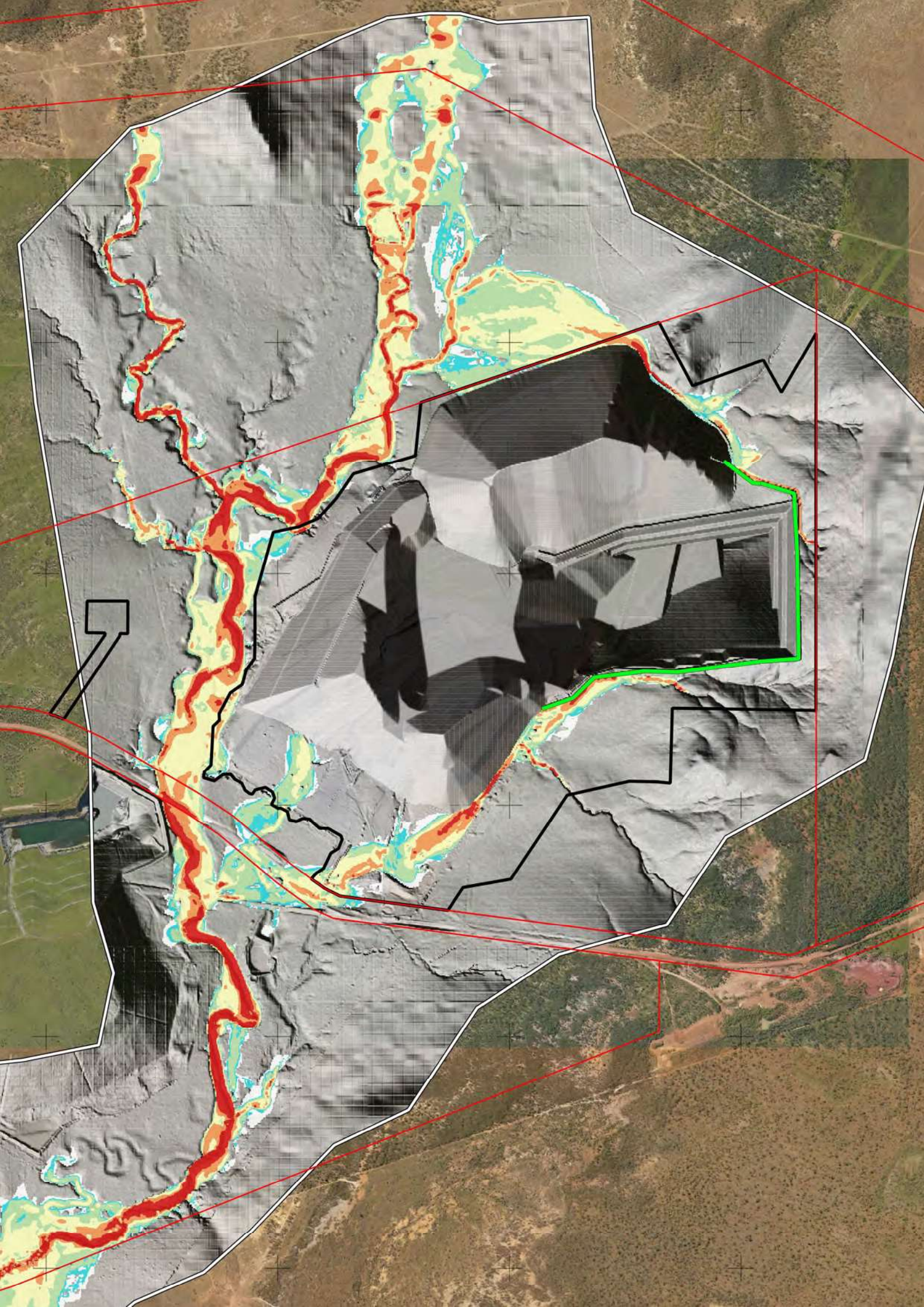


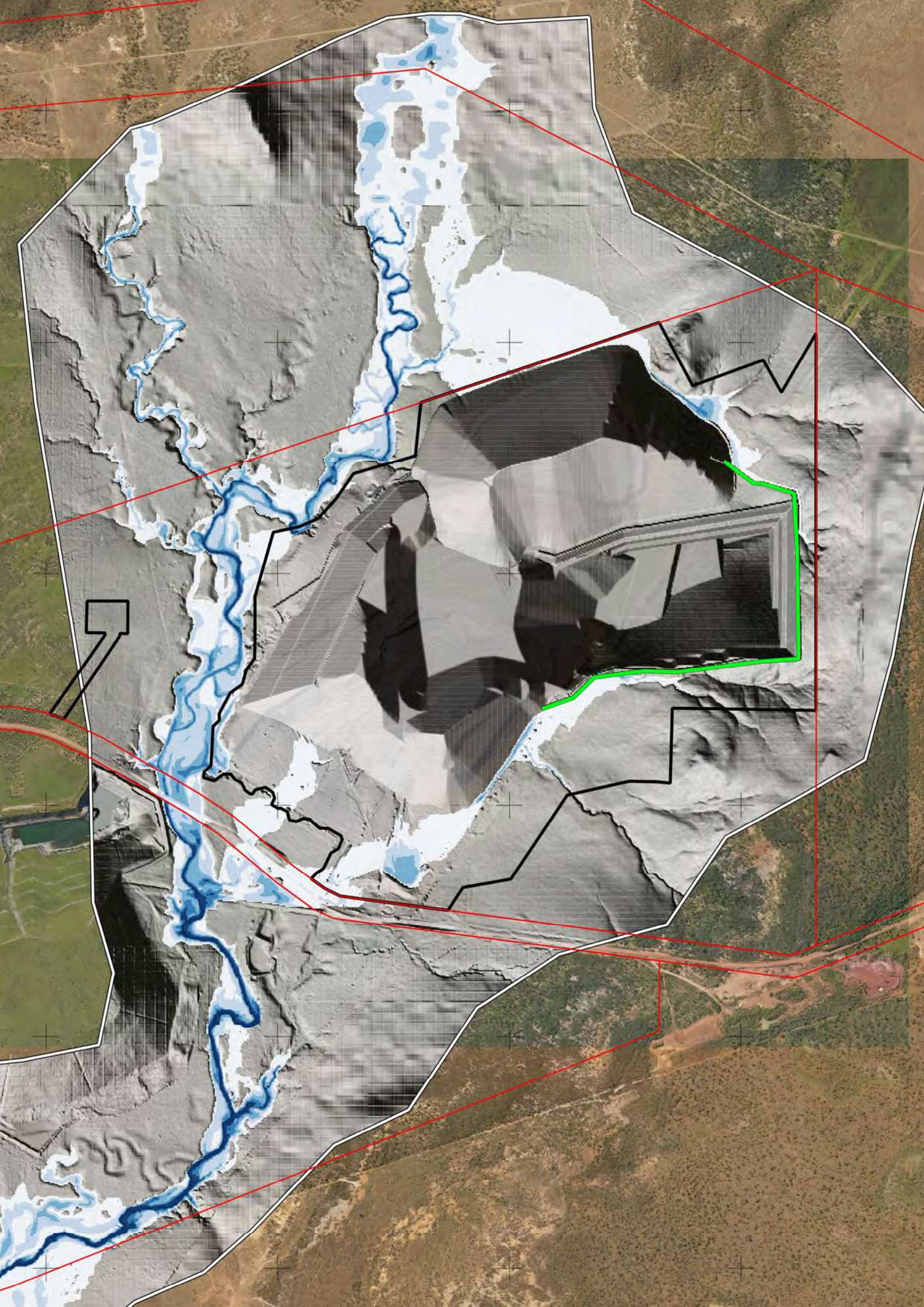


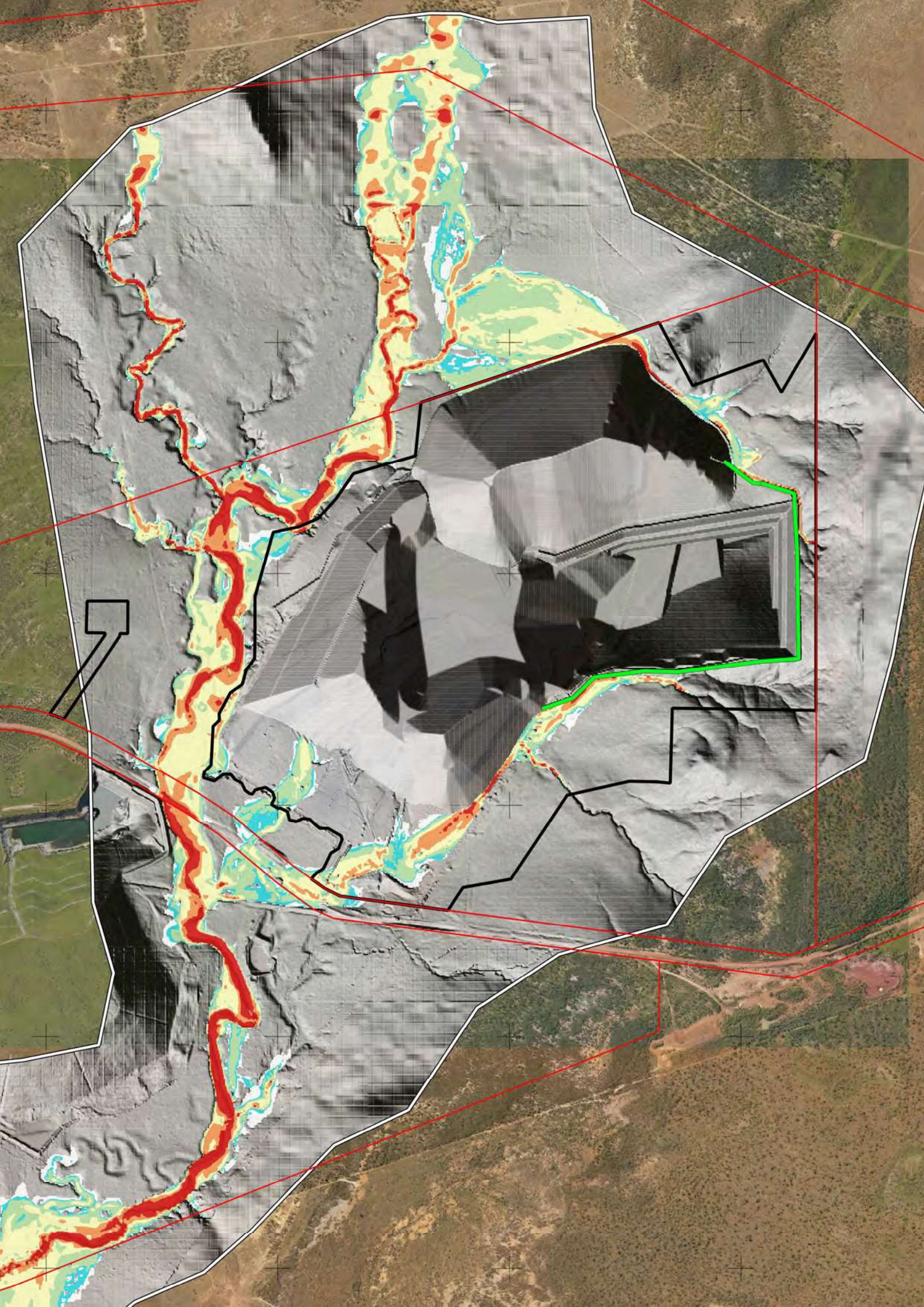


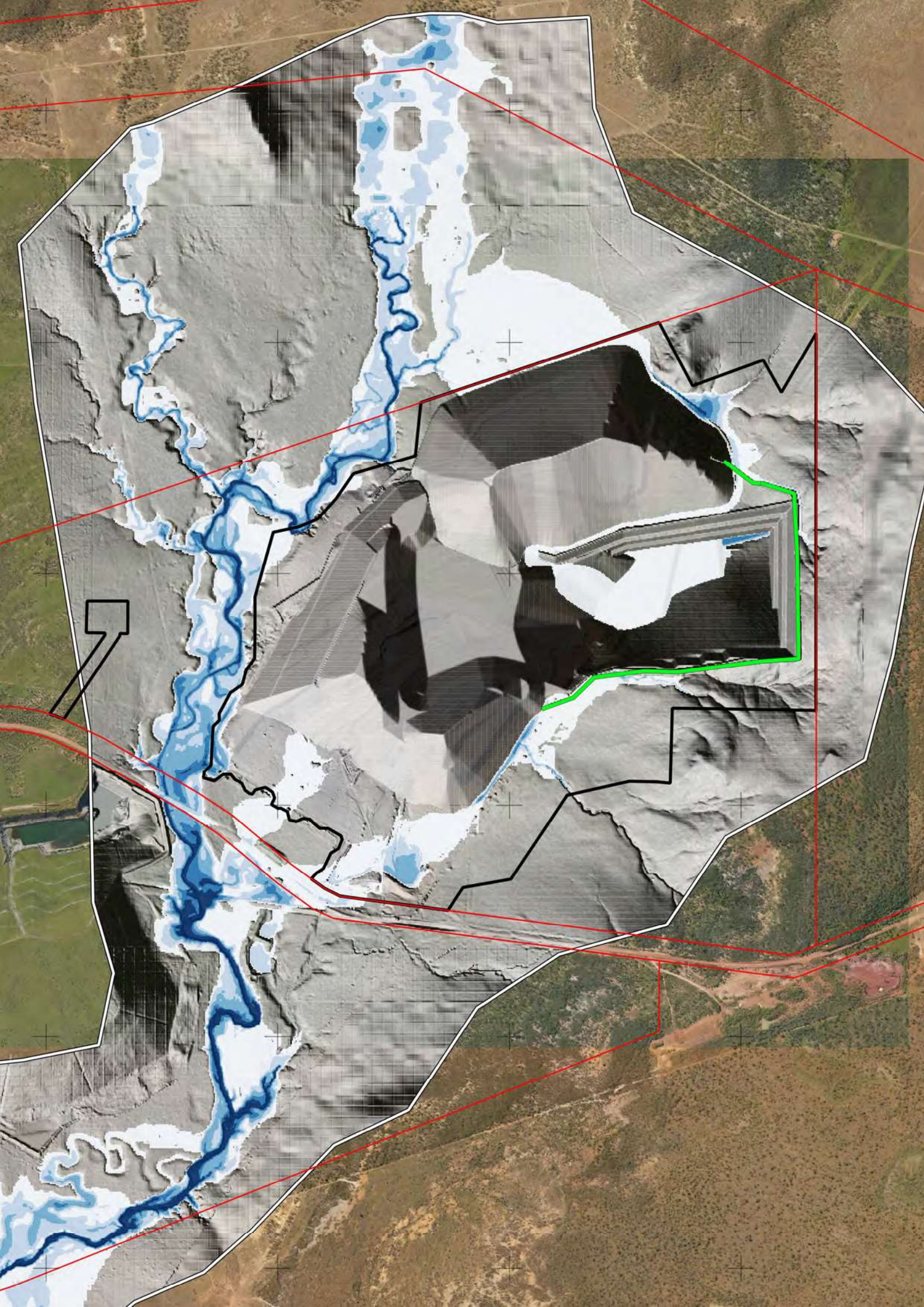
APPENDIX B: CLIMATE CHANGE RESUTLS

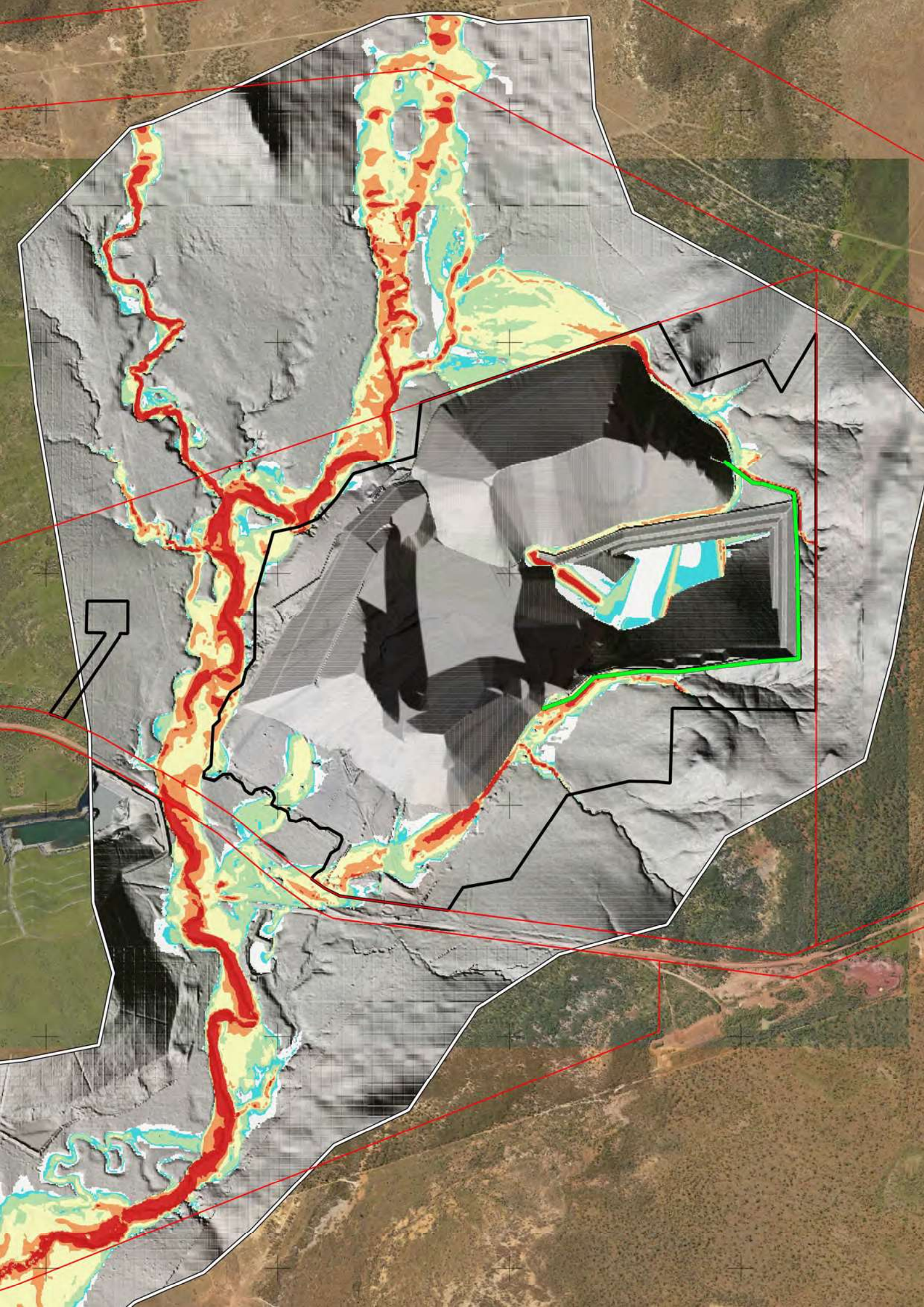


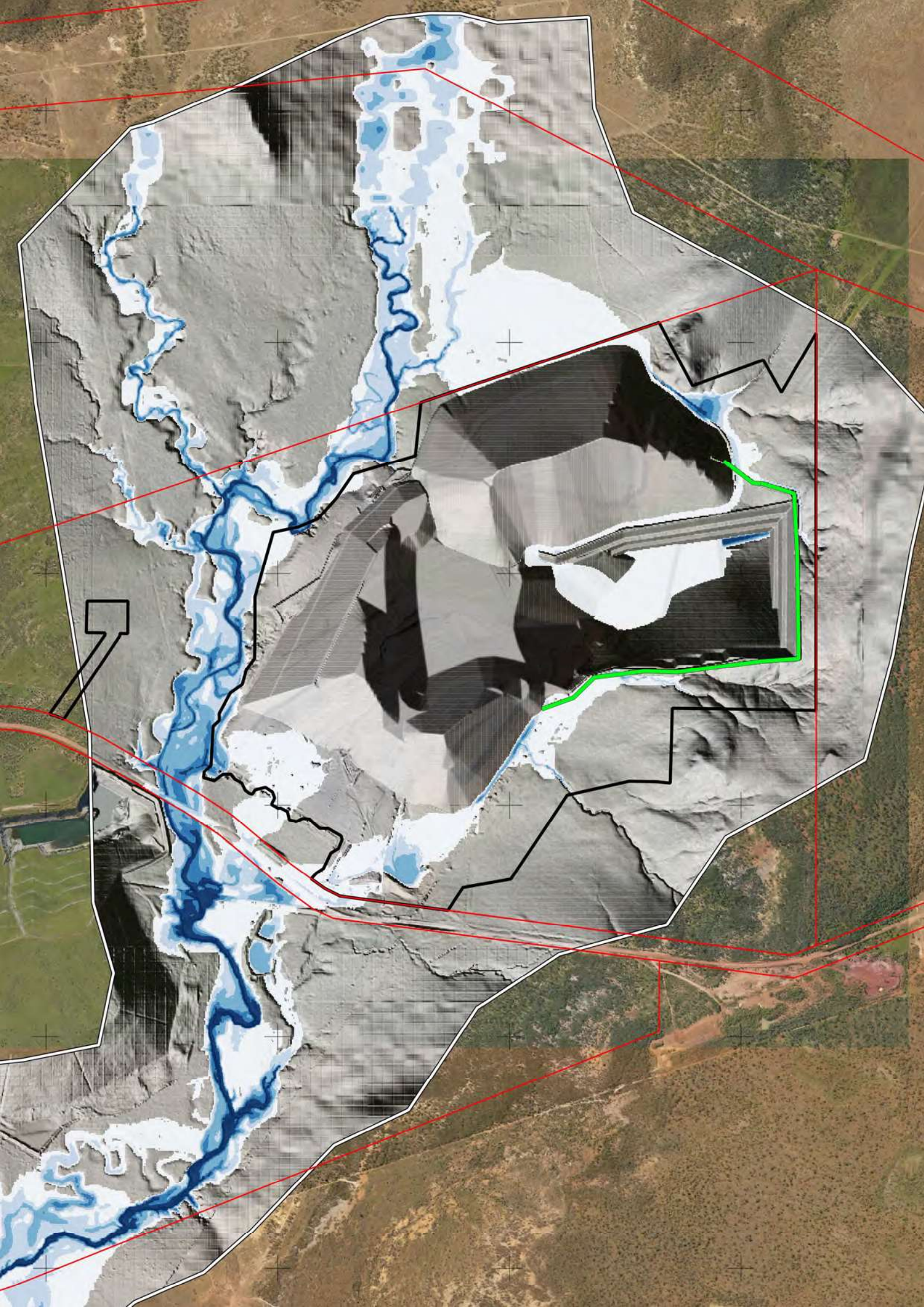


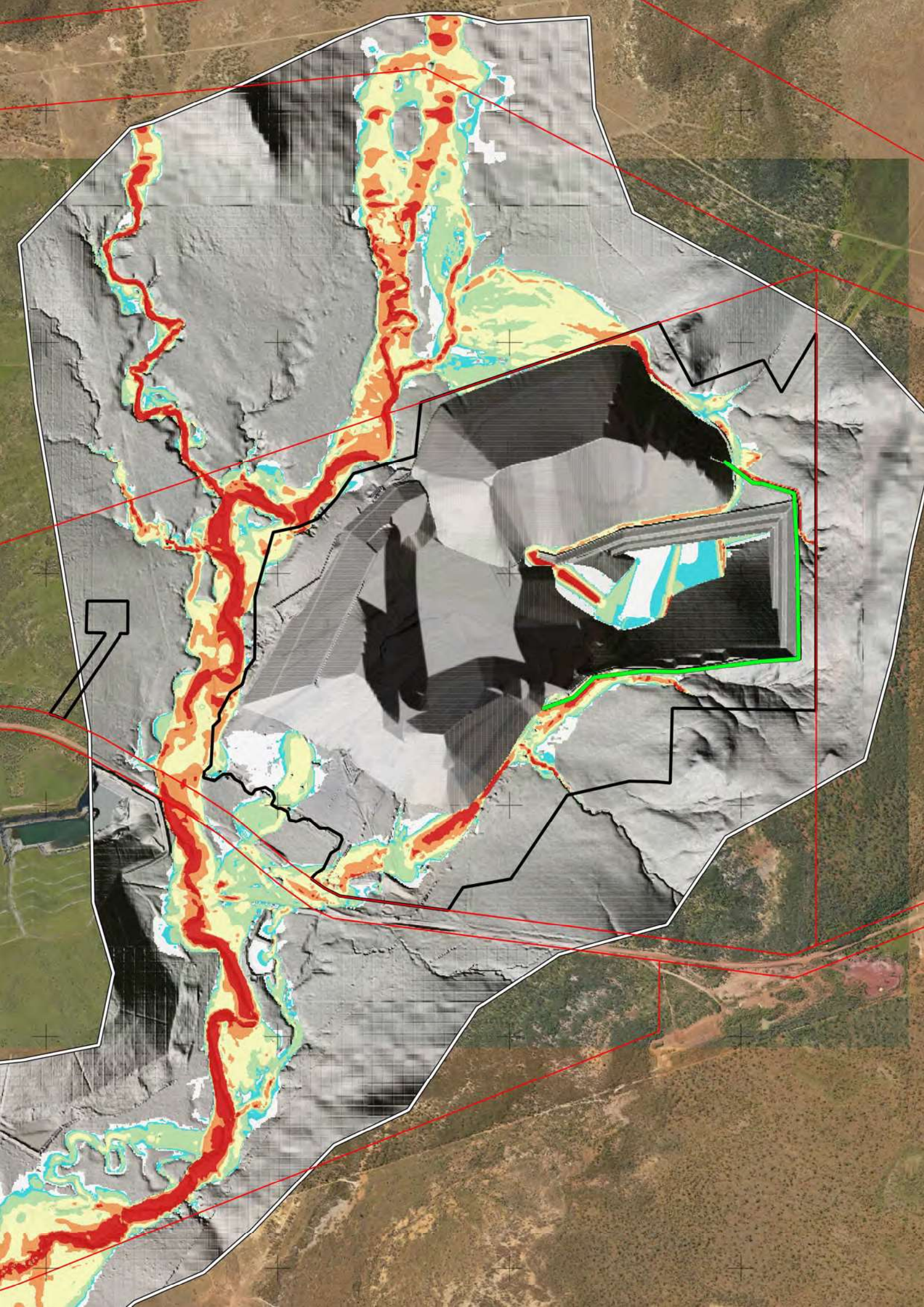




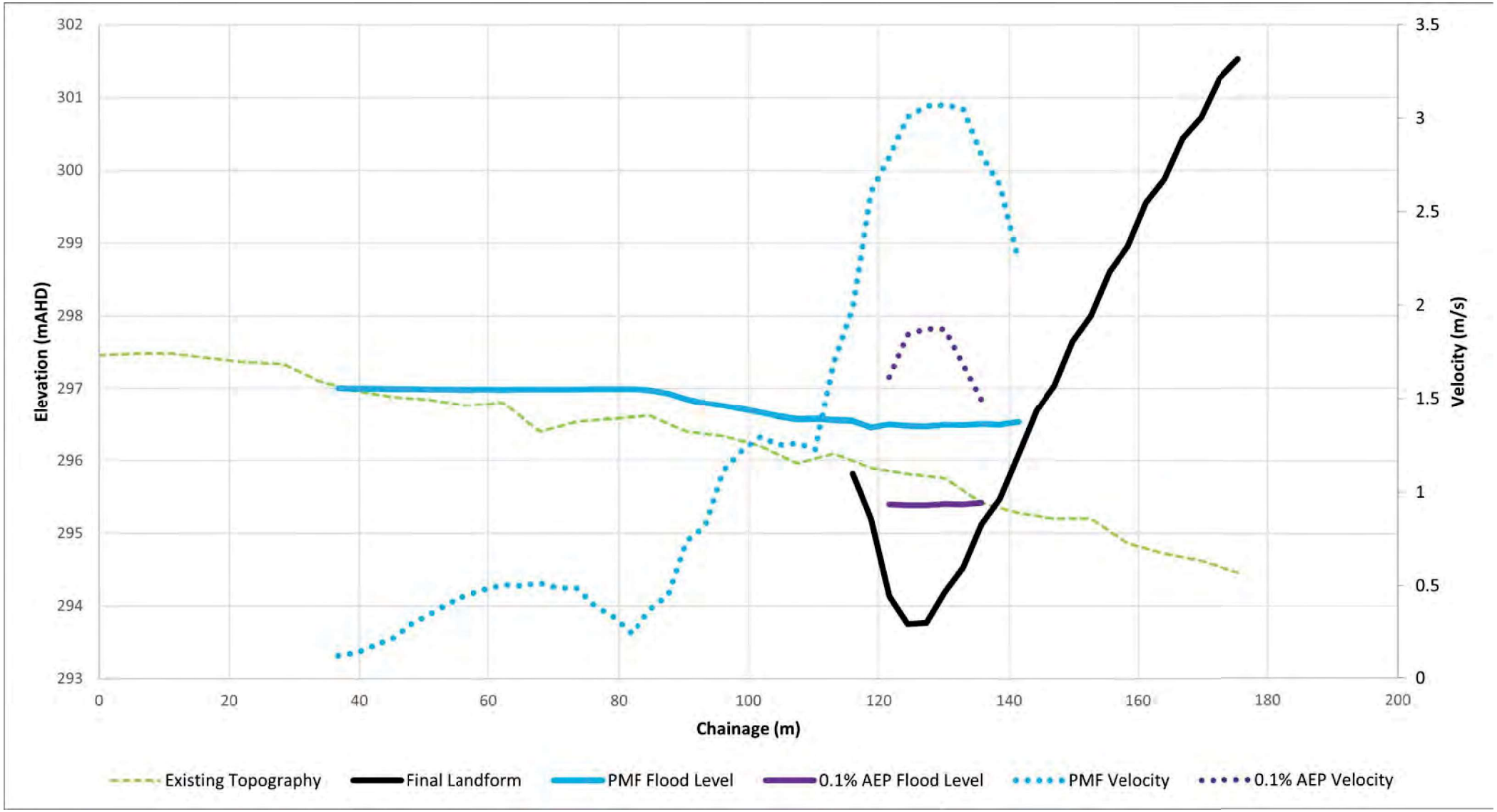


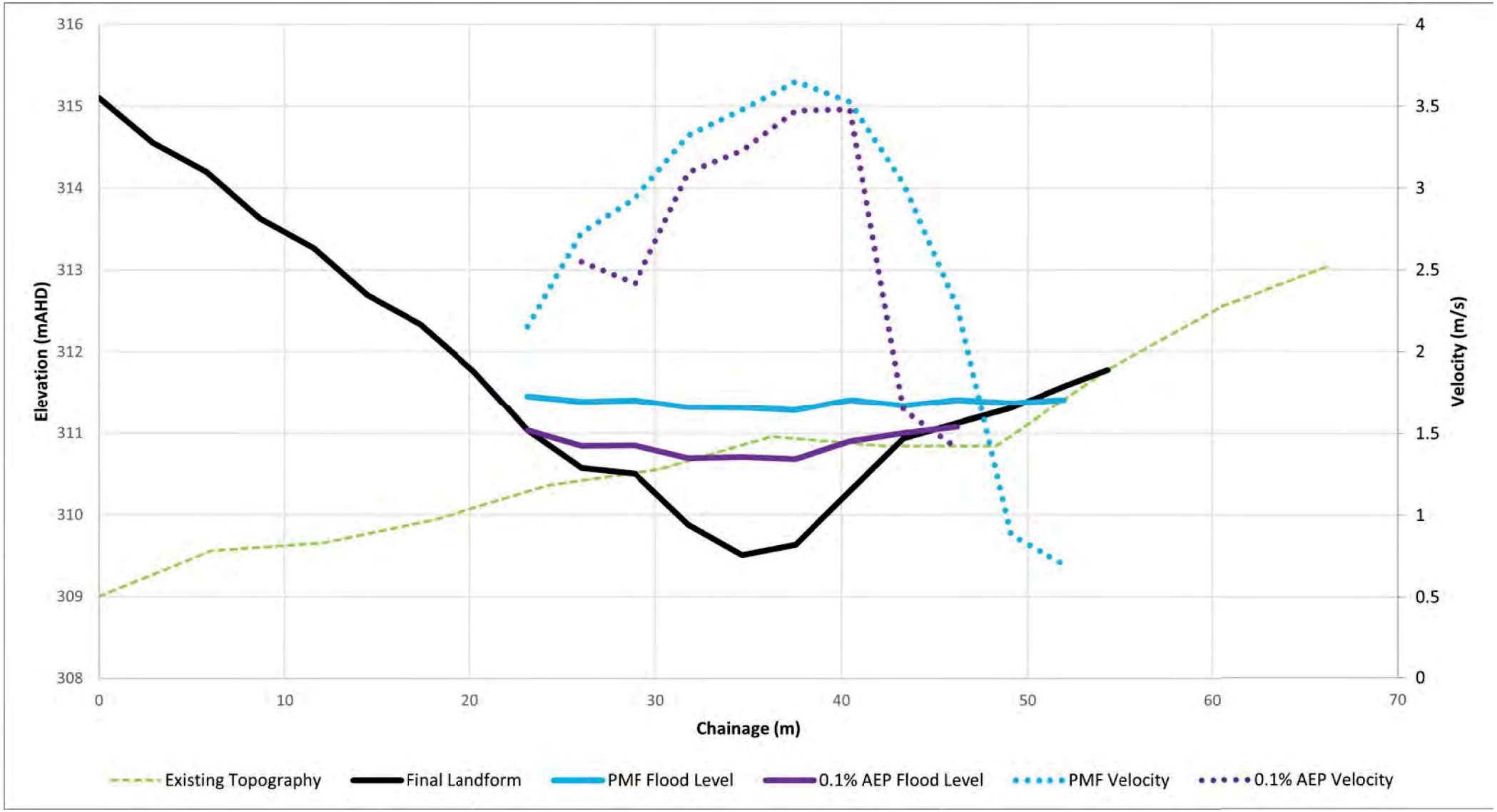






APPENDIX C: HYDRAULIC CROSS SECTION RESULTS


302
301
300
299
298
297
296
295
294
293
Elevation (mAHD)
3.5
3
2.5
2
1.5
1
0.5
0
Velocity (m/s)
0
20
40
60
80
100
120
140
160
180
200
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-001-2

26 FEBRUARY 2024

DISCLAIMER

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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
2	26/02/2024	Table 3.7 Update	Chris Harris	Samantha Breslin	Chris Harris	Samantha Breslin
Signatures:						

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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).

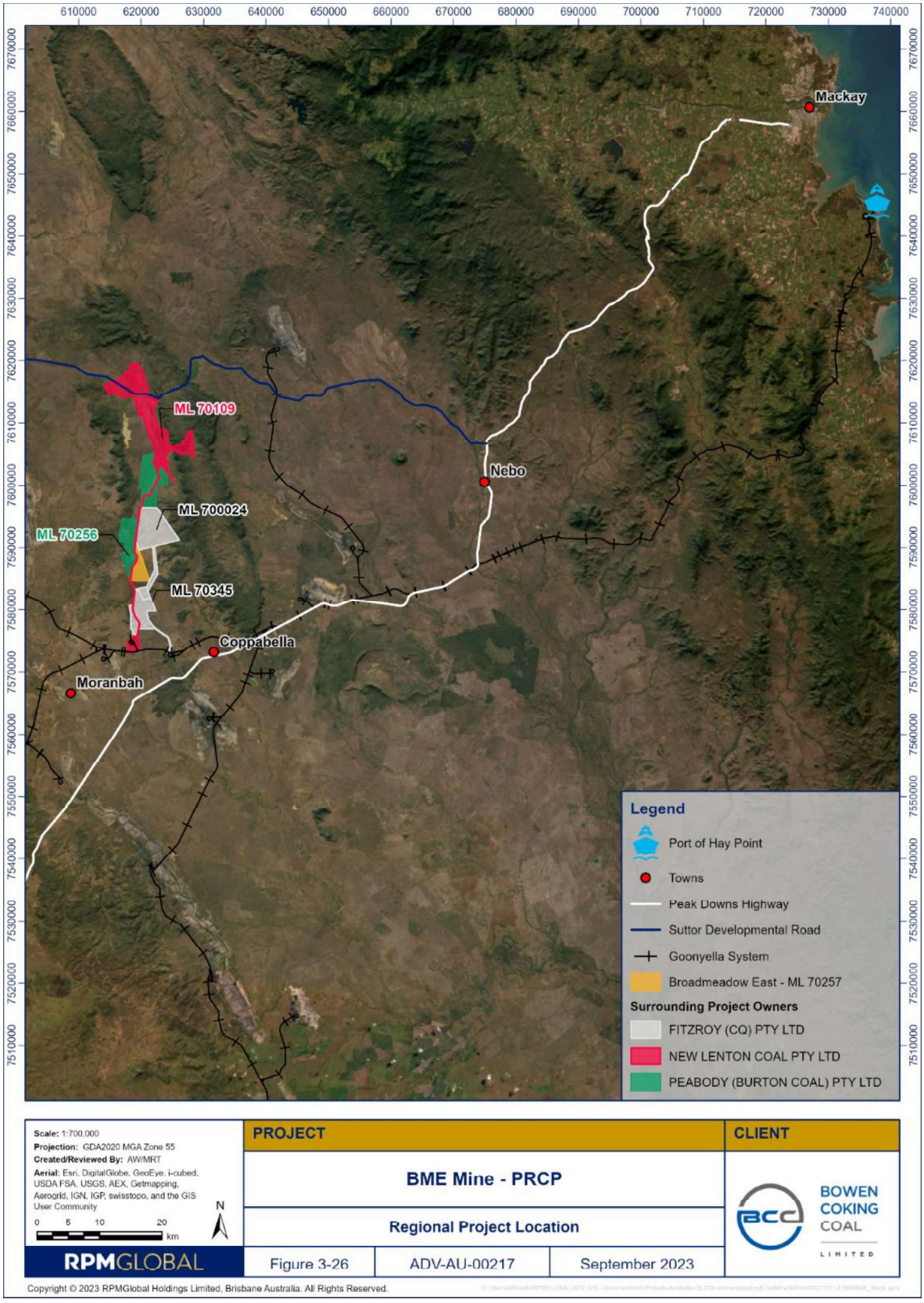


Figure 2.1: Site Location

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.

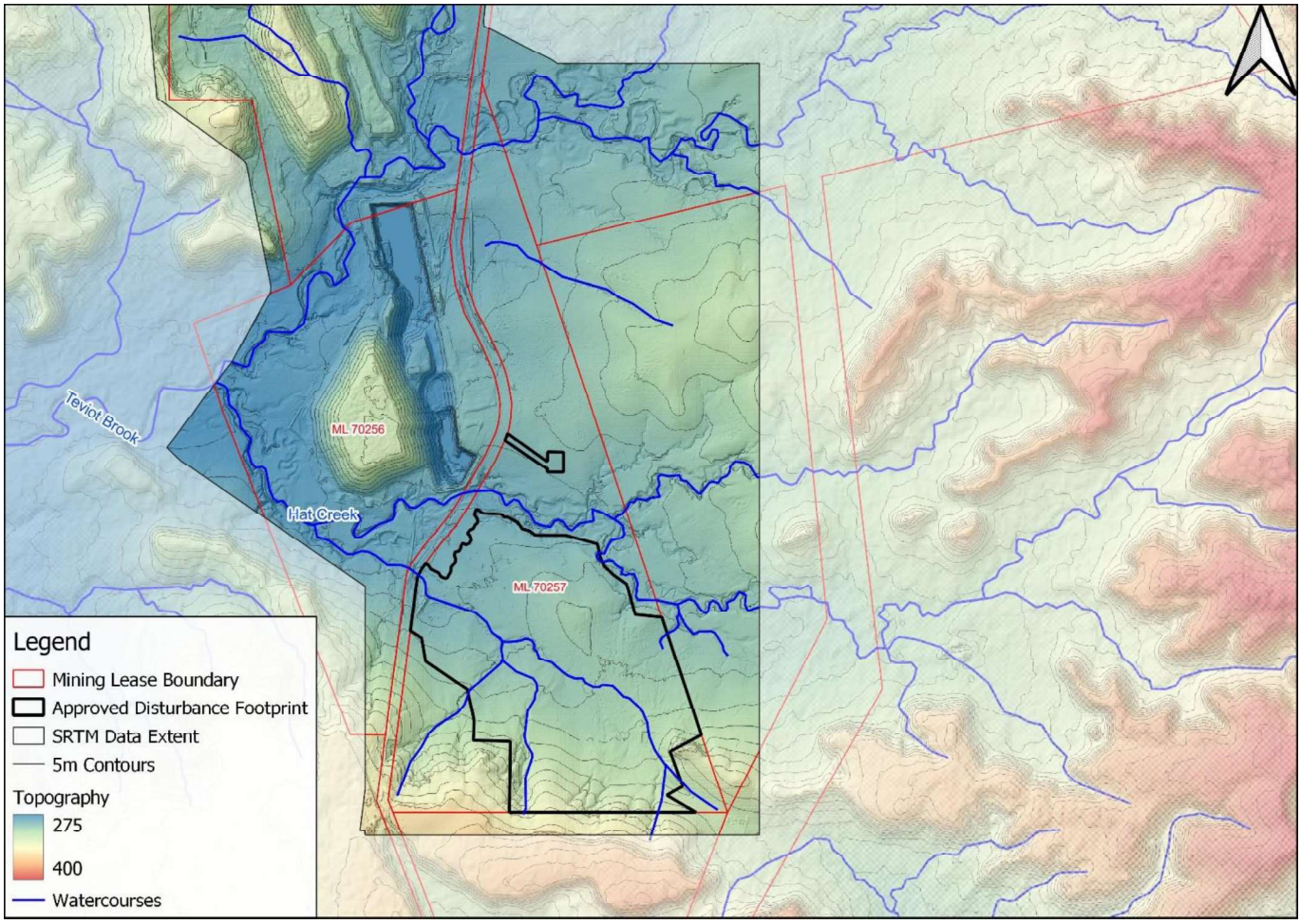


Figure 2.2: Existing Site Topography

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.

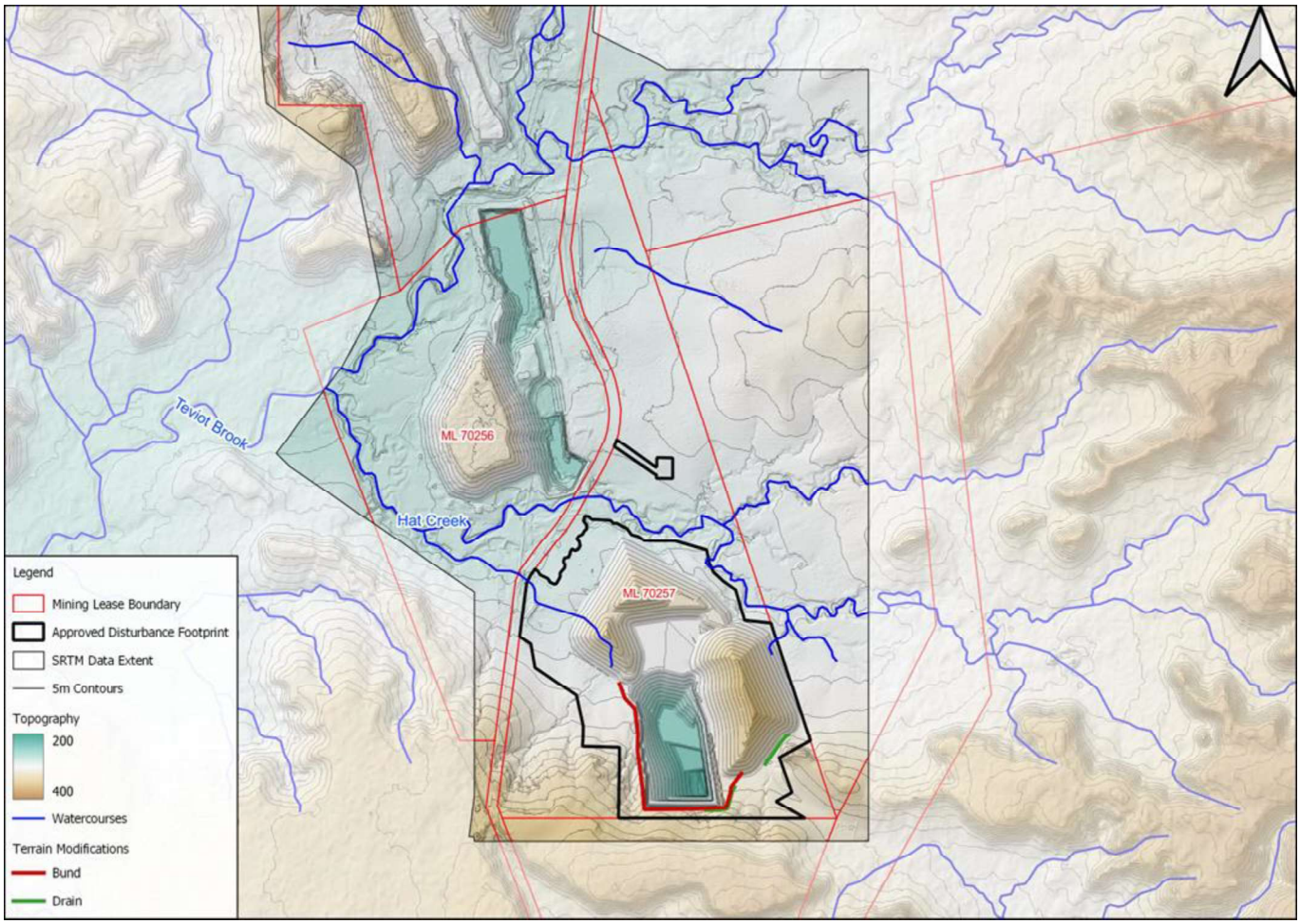


Figure 2.3: Final Landform

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 = $\frac{1}{\left[1+\frac{Salinity\ (ppm)}{10\text{^}6}\right]}$ where, salinity (ppm) = Total Dissolved Solids (TDS) (mg/L).

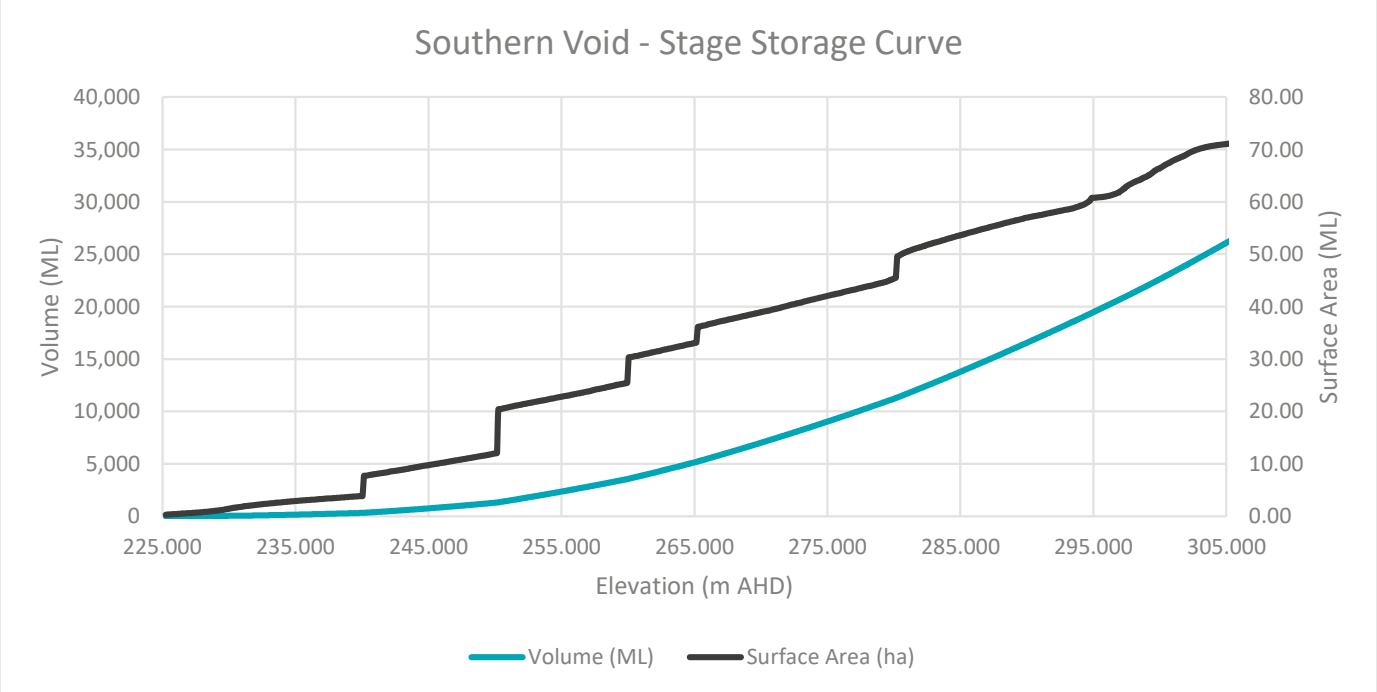


Figure 3.1: South Pit - Final Void Storage Characteristics

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.

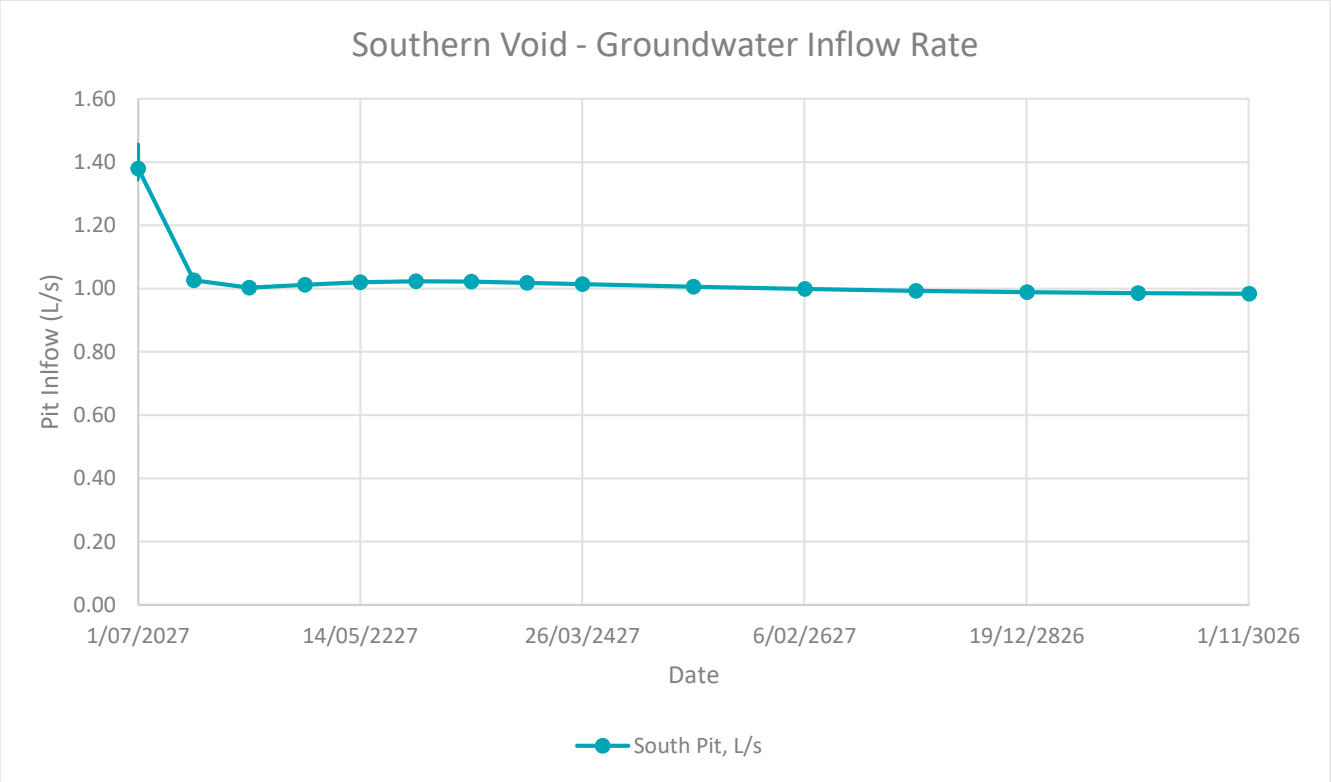


Figure 3.2: Southern Void Groundwater Ingress Curve (KCB, 2023)

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 .

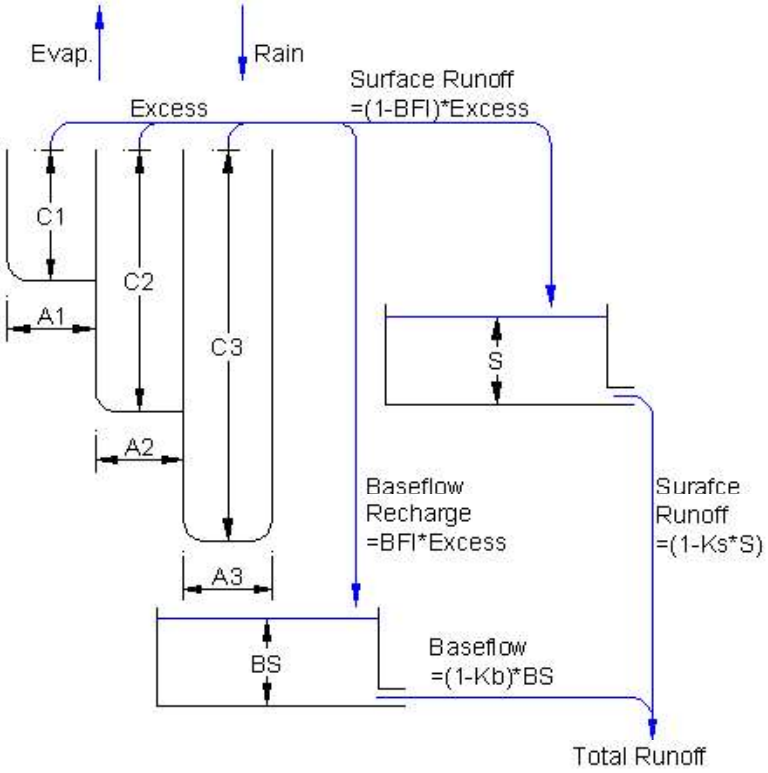


Figure 3.3: AWBM Schematic

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)	Average Void EC at 300 years (µS/cm)	Maximum Void EC at 300 years (µS/cm)[2.]	Initial Void Filling Period (Years)
South Pit	167	249.0	254.1	300	288.8	1,130	10.7	36,254	131,306	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.

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TECHNICAL REPORT

Mine material assessment and landform stability assessment

Prepared for: Coking Coal One Pty Ltd

MINE WASTE AND
WATER MANAGEMENT

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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.

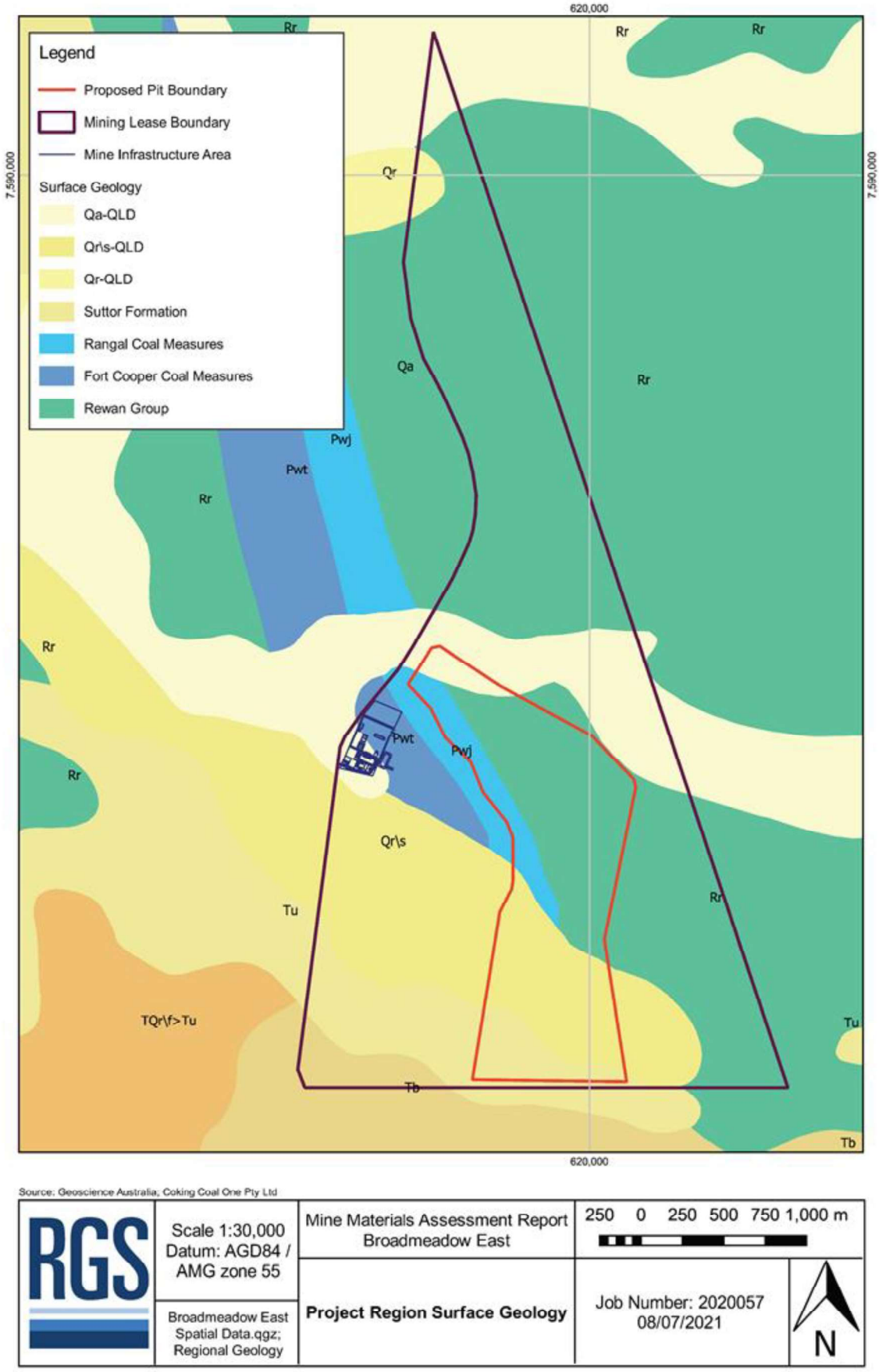


Figure 2-1. Regional geology

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**).

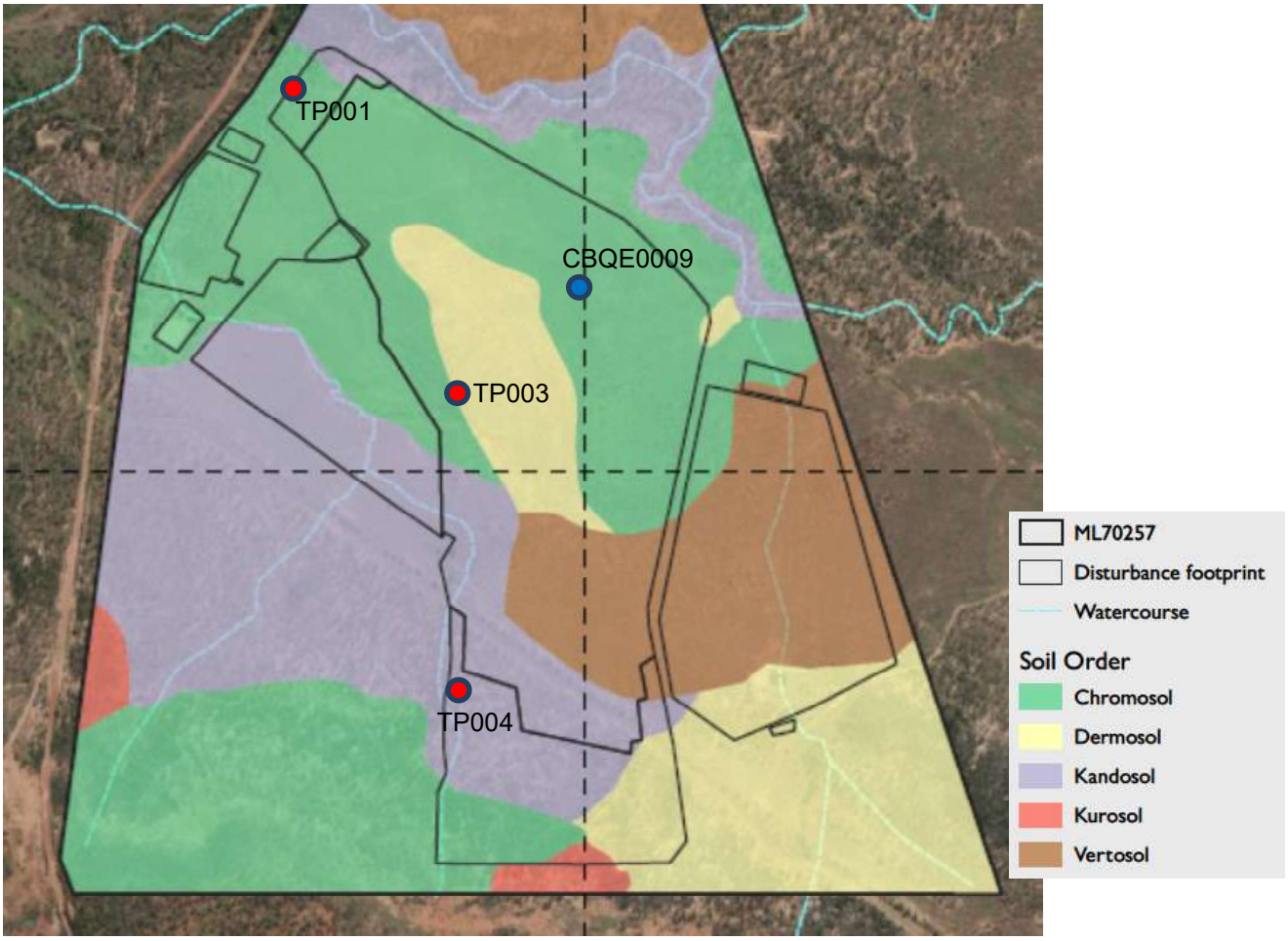


Figure 2-2: Mapped soil types (SGM, 2021)

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

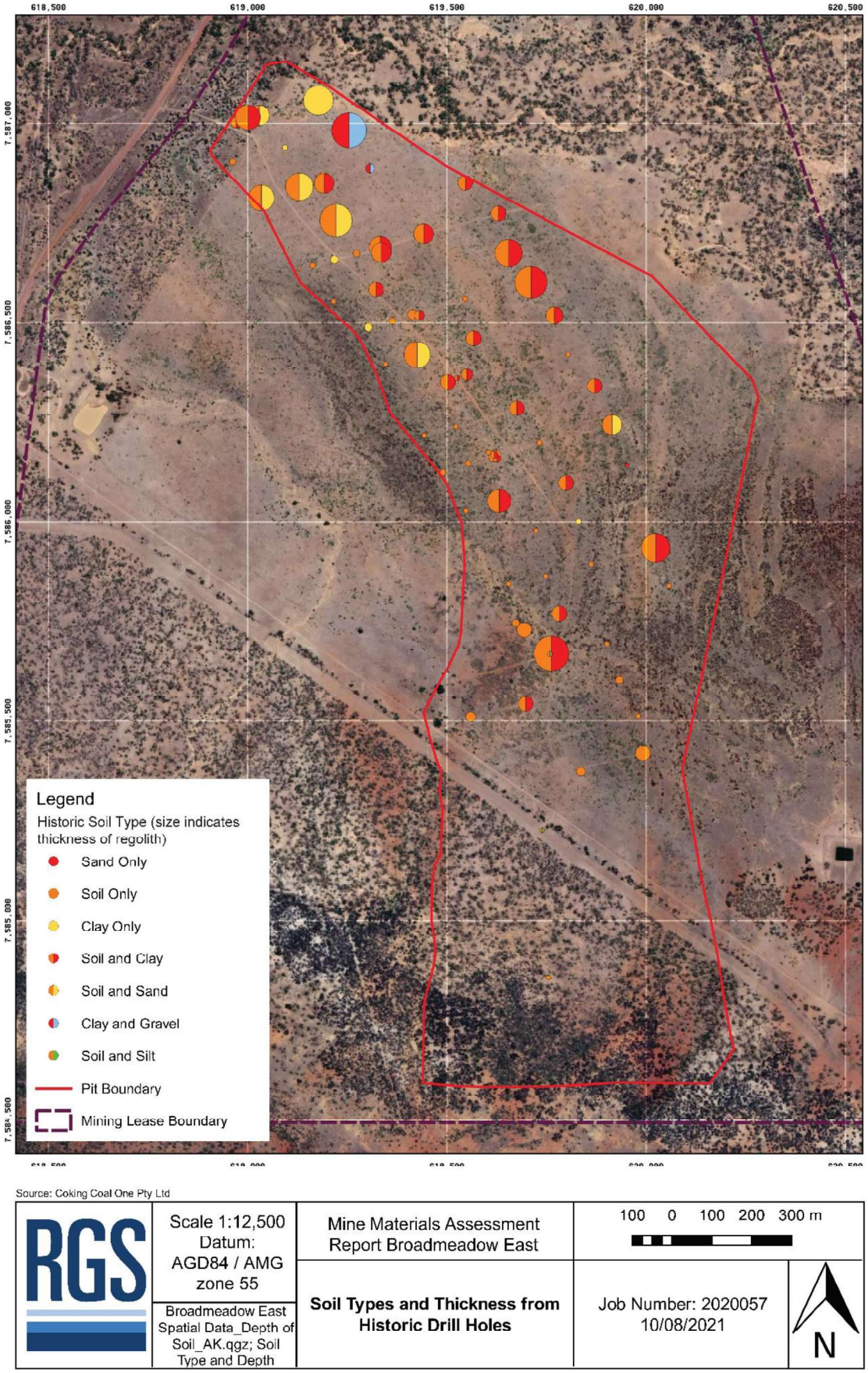


Figure 2-3. Historic soil types and thickness

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

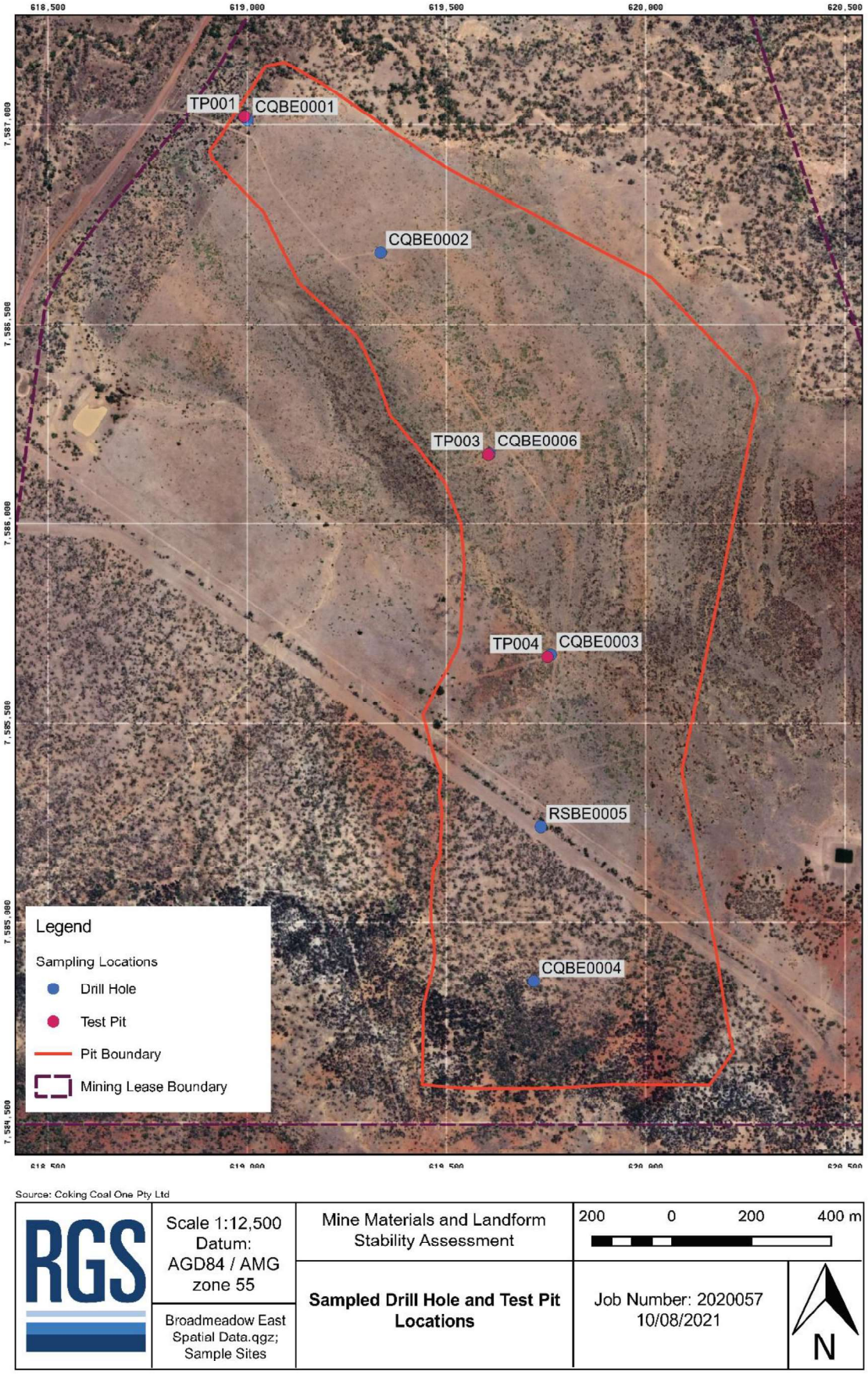


Figure 3-1. Sample sites

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**.

	ALS Code	Method Code	Number of a
	IN-4S	APHA 4500 H+ - B and APHA 2510 B	73
S)	ASS-1	III. Coastech Research (Canada)	73
(S_{cr})	EA026	Ahern et al (2004)	32

	ALS Code	Method Code	Number of a
mental analysis (Total) 49 elements: Ag, Al, As, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, In, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, n, Zr	ME-MS41 - 2 acid aqua regia digest		32
	EG035T	APHA 3112 Hg-B CV/FIMS	32
	EK040T	EK040T In-house Fusion	32

ch method (1:3 and 16-hour leach for water soluble elements)	ALS Code	Method Code	Number of a
	EA005P and EA010P	APHA 4500 H+ - B and APHA 2510 B	32
nate, Carbonate, Hydroxide & Total as CaCO3	ED037	APHA 2320 B	32
	ED038	APHA 2310 B	32
and K) [ICP-AES/MS (1:3 w:v water extracts)] and major anions (Cl, F, and SO4) tor (1:3 w:v water extracts)]	NT-1 & NT-2	APHA 3120B, APHA 3125B	32
elements: (Ag, Al, As, B, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, u, Mn, Mo, Nb, Ni, P, Pr, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, MS (1:3 w:v water extracts)]	EG020F (ME-02)	USEPA 6020 ICP/MS	32
KN, NOx) Total Phosphorous	NT-11		32
P by discrete analyser	EK071G	APHA 4500 P – F	32
	EG035F	APHA 3112 Hg-B CV/FIMS	32

	ALS Code	Method Code	Number of a
	EA02 and EA010	APHA 4500 H+ - B and APHA 2510 B	30
Mg, Na, K) plus ECEC & ESP on Alkaline Soils (pH > 7.3)	ED006	Soil Survey Test Method C5	30
Mg, Na, K) plus ECEC & ESP with pre-treatment on Soils (pH <7.3 and EC ECEC includes ED005 - Exchange Acidity (includes Exchangeable	ED008	Rayment & Lyons 2011 15A1 ED005 - Rayment & Lyons 2011 15G1	30
Discrete Analyser	EK067G	APHA 4500-P	30
horus (Bray)	EK074	Rayment & Lyons 2011 9E1	30
s Organic Carbon by Calc' (Walkley Black)	EP004	AS 1289.4.1.1-1997/ NEPM	30
A010 + 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
olwell P and K, DTPA extractable Fe, Cu, Zn and Mn, Organic Matter and 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

	Code	Method Code	Number of a
ametral or irregular lump	Based on method	*Samples intact enough to meet minimum requirements for testing*	5

gram for test pit samples

	ALS Code	Method Code	Number of a
	EA02 and EA010	APHA 4500 H+ - B and APHA 2510 B	12
Mg, Na, K) plus ECEC & ESP on Alkaline Soils (pH > 7.3)	ED006	Soil Survey Test Method C5	12
Mg, Na, K) plus ECEC & ESP with pre-treatment on Soils (pH <7.3 and EC ECEC includes ED005 - Exchange Acidity (includes Exchangeable	ED008	Rayment & Lyons 2011 15A1 ED005 - Rayment & Lyons 2011 15G1	12
Discrete Analyser	EK067G	APHA 4500-P	12
horus (Bray)	EK074	Rayment & Lyons 2011 9E1	12
s Organic Carbon by Calc' (Walkley Black)	EP004	AS 1289.4.1.1-1997/ NEPM	12

ng STD compaction)	Based on method		4
	Based on method		4
Mould Standard - 1 litre	Based on method		4
lling head) (90% Proctor)	Based on method		4
Clay Mineralogy	Based on method		4
urve (10 Point)	Based on method		12
	Based on method	AS1289.3.8.1	12
1:3 solid/water ratio	Based on method		12

gram for coal quality samples

	ALS Code	Method Code	Number of a
	EA02 and EA010	APHA 4500 H+ - B and APHA 2510 B	32
S)	ASS-1	III. Coastech Research (Canada)	32
(CRS)	EA026	Ahern et al (2004)	32
	ALS Code	**Method Code**	**Number of a**
nental analysis (Total) 49 elements: Ag, Al, As, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, r	ME-MS41 - 2 acid aqua regia digest		3
	EG035T	APHA 3112 Hg-B CV/FIMS	3
	EK040T	EK040T In-house Fusion	3
ch method (1:3 and 16-hour leach for water soluble elements)	**ALS Code**	**Method Code**	**Number of a**
	EA005P and EA010P	APHA 4500 H+ - B and APHA 2510 B	3
nate, Carbonate, Hydroxide & Total as CaCO3	ED037	APHA 2320 B	3
	ED038	APHA 2310 B	3
and K) [ICP-AES/MS (1:3 w:v water extracts)] and major anions (Cl, F, and SO4) tor (1:3 w:v water extracts)]Cations - Dissolved: Calcium, Magnesium, Sodium, (Cl, SO_4, Alkalinity), Fluoride	NT-1 & NT-2	APHA 3120B, APHA 3125B	3
elements: (Ag, Al, As, B, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, u, Mn, Mo, Nb, Ni, P, Pr, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, MS (1:3 w:v water extracts)]Trace metals by ICP/MS (including digestion)	EG020F (ME-02)	USEPA 6020 ICP/MS	3
KN, NOx) Total Phosphorous	NT-11		3
P by discrete analyser	EK071G	APHA 4500 P – F	3
	EG035F	APHA 3112 Hg-B CV/FIMS	3
	Code	**Method Code**	**Number of a**
	EA005P & EA010P		6
	EG035F	APHA 3112 Hg-B CV/FIMS	6
	EN055- PG		6
Full Scan	ME-02	USEPA 6020 ICP/MS	6
K)	NT-01		6
oride, Alkalinity)	NT-02A		6
	ED038P CaCO3	APHA 2310 B	6
	ED040F		6
– Suite D	EG020D-F		6
S	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**).

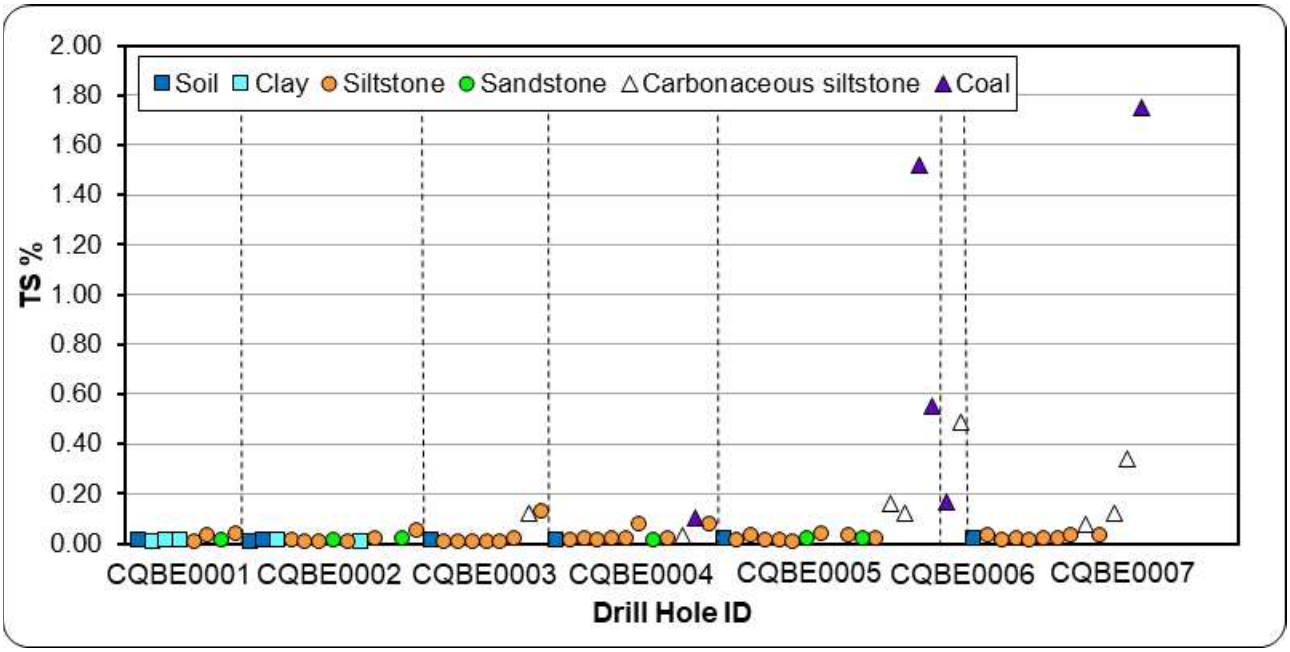


Figure 5-1. TS in drill hole samples

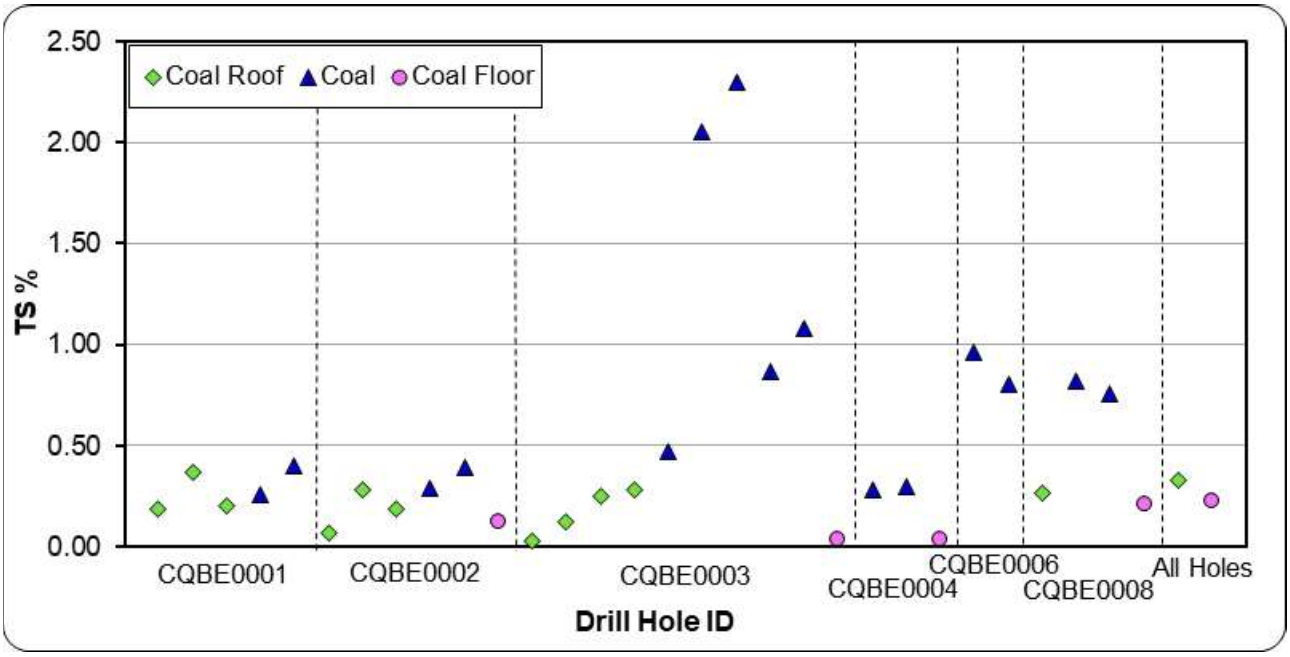


Figure 5-2. TS in coal quality samples

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**).

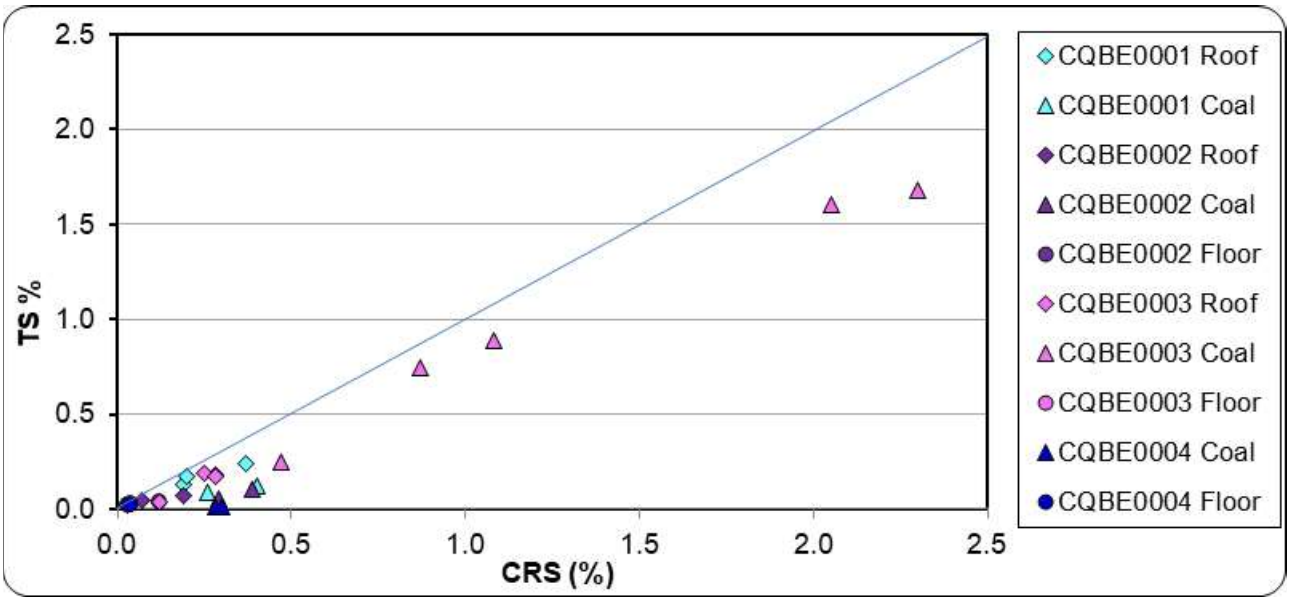


Figure 5-3. TS vs CRS for coal quality samples

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 (MPA[2]) (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 MPA[2] (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 MPA[2] 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 MPA[2] 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**).

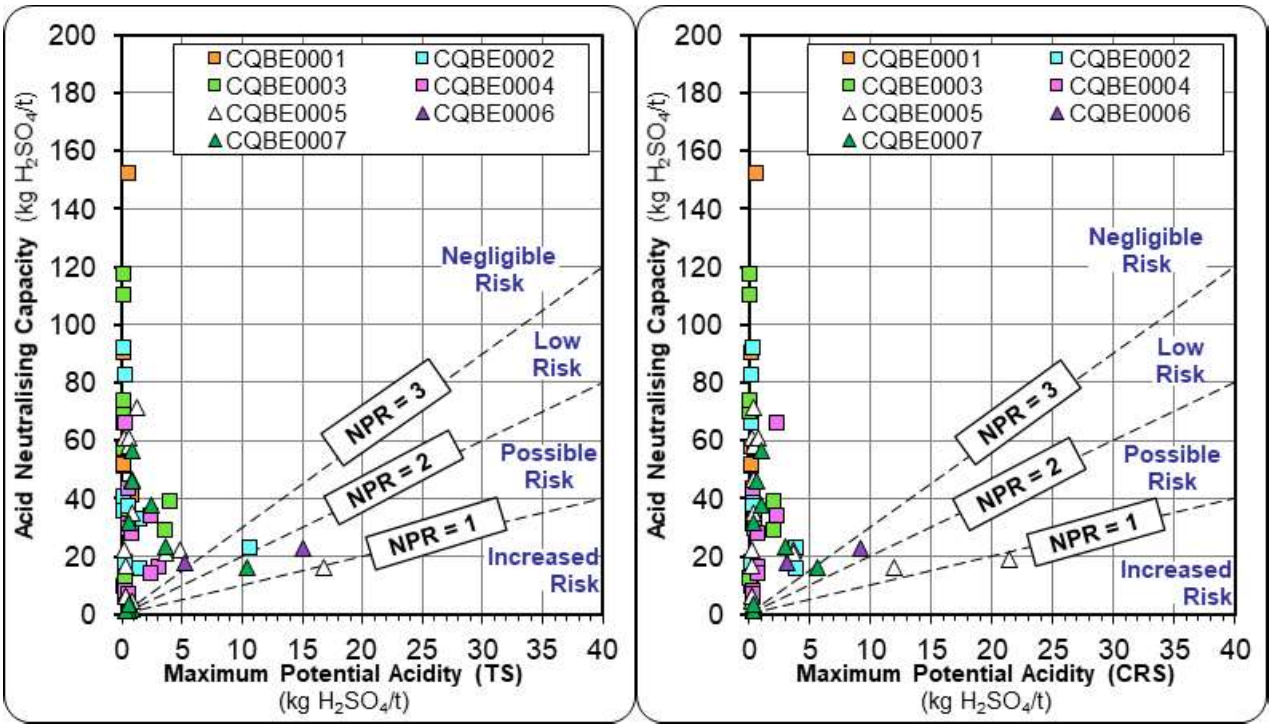


Figure 5-4. NPR (TS and CRS) for drill hole samples

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 MPA[2] 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 MPA[2] 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**).

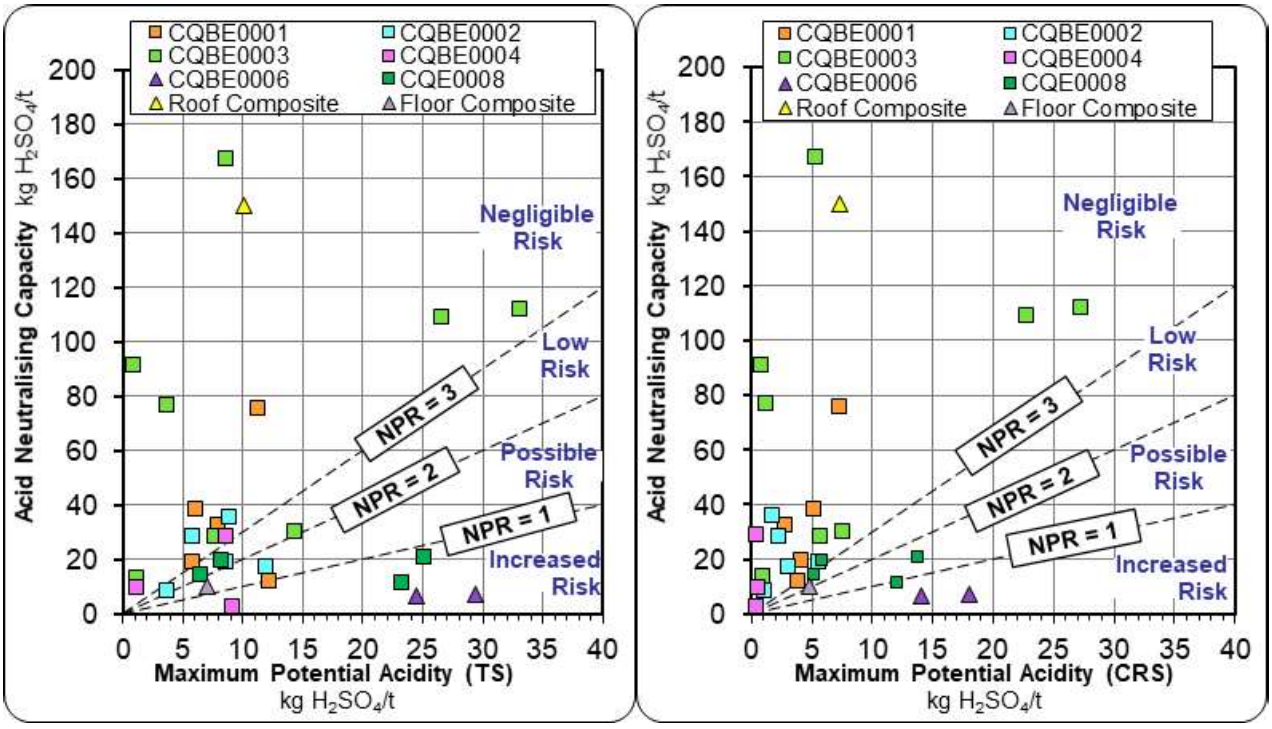


Figure 5-5. (TS and CRS) for coal quality samples

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).

Minimum	Maximum	Median	Minimum	Maximum	Median	Minimum	Maximum
0.01	0.10	0.06	0.03	0.12	0.08	0.02	0.11
740.00	1920.00	1340.00	990.00	2250.00	1420.00	430.00	1580.00
3.40	9.20	7.10	2.80	22.90	11.00	1.50	31.70
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5.00	10.00	10.00	5.00	10.00	5.00	5.00	5.00
110.00	220.00	165.00	40.00	400.00	115.00	50.00	1160.00
0.21	0.87	0.85	0.81	1.52	1.16	0.38	1.17
0.10	0.19	0.13	0.16	0.47	0.32	0.13	0.40
30.00	2310.00	885.00	370.00	3530.00	1425.00	220.00	2600.00
0.01	0.07	0.02	0.05	0.15	0.10	0.04	0.13
4.17	20.70	15.10	8.20	21.70	15.13	6.45	13.45
1.80	18.30	12.45	7.60	27.10	15.25	2.50	19.00
19.00	90.00	39.50	9.00	27.00	15.00	3.00	11.00
0.48	1.65	1.42	1.32	5.58	2.06	0.53	5.00
14.90	23.90	19.30	22.40	55.90	43.75	19.40	58.10
3150.00	6330.00	4240.00	1200.00	5690.00	4005.00	1160.00	3670.00
3.11	7.09	5.07	2.63	7.84	5.21	0.98	5.13
0.05	0.08	0.06	0.03	0.07	0.06	0.03	0.09
0.10	0.18	0.13	0.11	0.20	0.14	0.08	0.12
0.01	0.01	0.01	0.01	0.12	0.03	0.03	0.31
0.03	0.04	0.03	0.03	0.08	0.05	0.02	0.06
30.00	150.00	115.00	120.00	270.00	165.00	40.00	240.00
1.60	6.80	6.35	3.00	8.70	5.60	2.40	4.90
2.10	9.50	6.20	7.60	13.90	9.85	3.30	12.40
20.00	560.00	265.00	300.00	600.00	515.00	90.00	560.00
25.00	881.00	513.50	123.00	1270.00	756.50	102.00	528.00
0.13	3.08	0.34	0.10	2.71	0.51	0.74	2.11
20.00	160.00	100.00	40.00	210.00	85.00	20.00	210.00
0.03	0.08	0.06	0.03	0.03	0.03	0.03	0.05
3.60	26.20	21.25	17.20	34.40	23.65	4.40	28.50
150.00	320.00	195.00	340.00	1350.00	795.00	270.00	2440.00
4.00	12.70	11.30	10.90	29.60	19.20	4.40	21.90
3.50	18.50	12.60	8.00	16.70	11.30	2.30	14.80
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	20.00	15.00	10.00	400.00	30.00	150.00	1900.00
0.17	0.46	0.30	0.12	0.95	0.33	0.13	0.82
4.80	7.10	5.60	4.60	8.20	7.10	2.50	6.10
0.20	0.90	0.35	0.20	0.80	0.30	0.50	0.80
0.40	0.80	0.65	0.60	1.20	0.75	0.30	0.70
6.00	88.60	45.20	30.90	168.50	87.55	71.70	159.50
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.03	0.04	0.03	0.02	0.09	0.05	0.03	0.07
2.30	3.60	2.90	2.00	4.60	3.55	1.30	5.20
2.50	14.00	6.50	2.50	2.50	2.50	2.50	2.50
0.02	0.13	0.09	0.01	0.08	0.06	0.01	0.07
0.29	0.59	0.40	0.33	0.66	0.49	0.29	0.94
45.00	205.00	75.00	24.00	54.00	39.50	10.00	31.00
0.15	0.51	0.24	0.03	0.53	0.06	0.03	0.09
1.15	9.94	8.42	4.94	14.05	10.50	3.47	13.10

0	6	0	0	Ag	0	22	0	0	Ag	0	7	
0	0	1	5	Al	0	0	8	14	Al	0	0	
0	6	0	0	As	0	13	9	0	As	0	4	
0	0	3	3	B	0	0	21	1	B	0	0	
0	0	2	4	Ba	0	0	16	6	Ba	0	0	
0	6	0	0	Be	0	22	0	0	Be	0	7	
0	6	0	0	Bi	0	22	0	0	Bi	0	7	
0	0	1	5	Ca	0	0	2	20	Ca	0	0	
3	3	0	0	Cd	14	8	0	0	Cd	2	5	
0	5	1	0	Ce	0	22	0	0	Ce	0	7	
0	6	0	0	Co	0	22	0	0	Co	0	5	
0	6	0	0	Cr	0	22	0	0	Cr	0	6	
0	6	0	0	Cs	0	22	0	0	Cs	0	7	
0	6	0	0	Cu	0	20	2	0	Cu	0	6	
0	6	0	0	Dy	0	22	0	0	Dy	0	7	
0	6	0	0	Er	0	22	0	0	Er	0	7	
0	6	0	0	Eu	0	22	0	0	Eu	0	7	
0	0	2	4	Fe	0	0	21	1	Fe	0	0	
0	6	0	0	Ga	0	22	0	0	Ga	0	7	
0	6	0	0	Gd	0	22	0	0	Gd	0	7	
0	6	0	0	Hf	0	22	0	0	Hf	0	7	
6	0	0	0	Hg	22	0	0	0	Hg	7	0	
0	6	0	0	Ho	0	22	0	0	Ho	0	7	
0	6	0	0	In	0	22	0	0	In	0	7	
0	0	1	5	K	0	0	0	22	K	0	0	
0	6	0	0	La	0	22	0	0	La	0	7	
0	5	1	0	Li	0	18	3	0	Li	0	2	
0	6	0	0	Lu	0	22	0	0	Lu	0	7	
0	0	1	5	Mg	0	0	4	18	Mg	0	0	
0	0	6	0	Mn	0	14	8	0	Mn	0	2	
0	6	0	0	Mo	0	7	15	0	Mo	0	3	
0	0	0	6	Na	0	0	0	22	Na	0	0	
0	6	0	0	Nd	0	22	0	0	Nd	0	7	
0	6	0	0	Ni	0	21	1	0	Ni	0	4	
0	5	1	0	Pb	0	20	2	0	Pb	0	6	
0	6	0	0	Pr	0	22	0	0	Pr	0	7	
0	6	0	0	Rb	0	22	0	0	Rb	0	6	
0	6	0	0	Sb	0	19	3	0	Sb	0	5	
0	6	0	0	Se	0	9	10	0	Se	0	2	
0	6	0	0	Sm	0	22	0	0	Sm	0	7	
0	6	0	0	Sn	0	22	0	0	Sn	0	7	
0	0	6	0	Sr	0	0	20	2	Sr	0	0	
0	6	0	0	Tb	0	22	0	0	Tb	0	7	
0	6	0	0	Te	0	22	0	0	Te	0	7	
0	6	0	0	Th	0	22	0	0	Th	0	7	
0	1	5	0	Ti	0	3	18	0	Ti	0	1	
0	6	0	0	Tl	0	22	0	0	Tl	0	7	
0	6	0	0	Tm	0	22	0	0	Tm	0	7	
0	6	0	0	U	0	22	0	0	U	0	7	
0	4	2	0	V	0	21	1	0	V	0	7	
0	6	0	0	Yb	0	22	0	0	Yb	0	7	
0	0	6	0	Zn	0	0	22	0	Zn	0	0	
0	6	0	0	Zr	0	22	0	0	Zr	0	7	

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**.

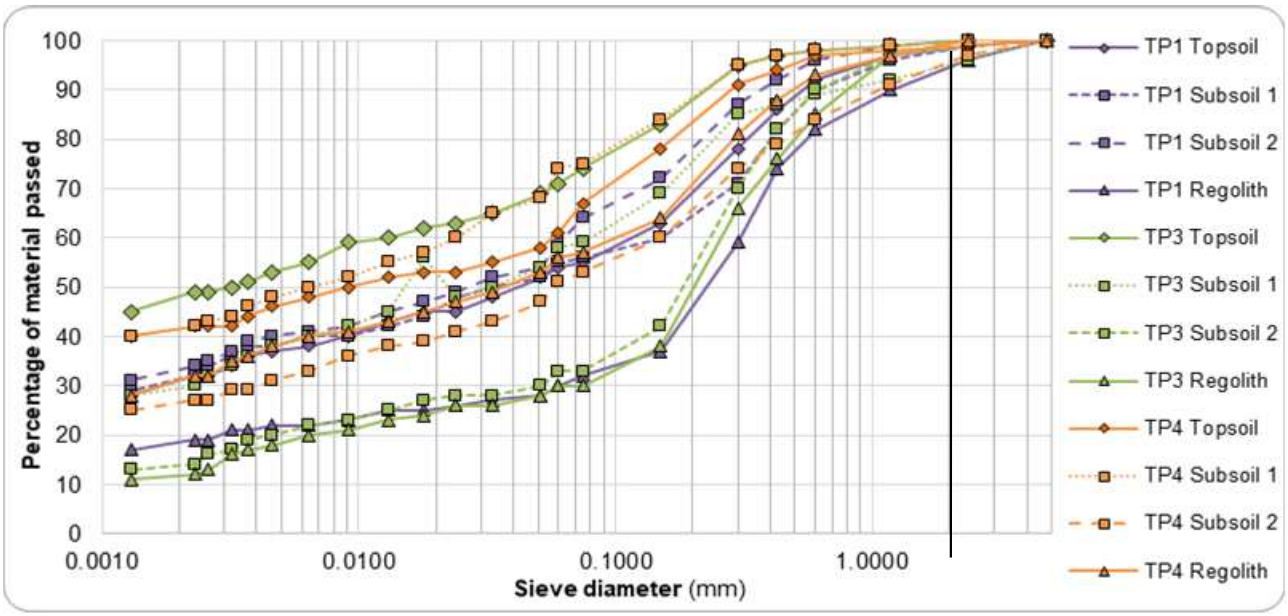


Figure 5-6. PSD and hydrometer for test pit samples

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**.

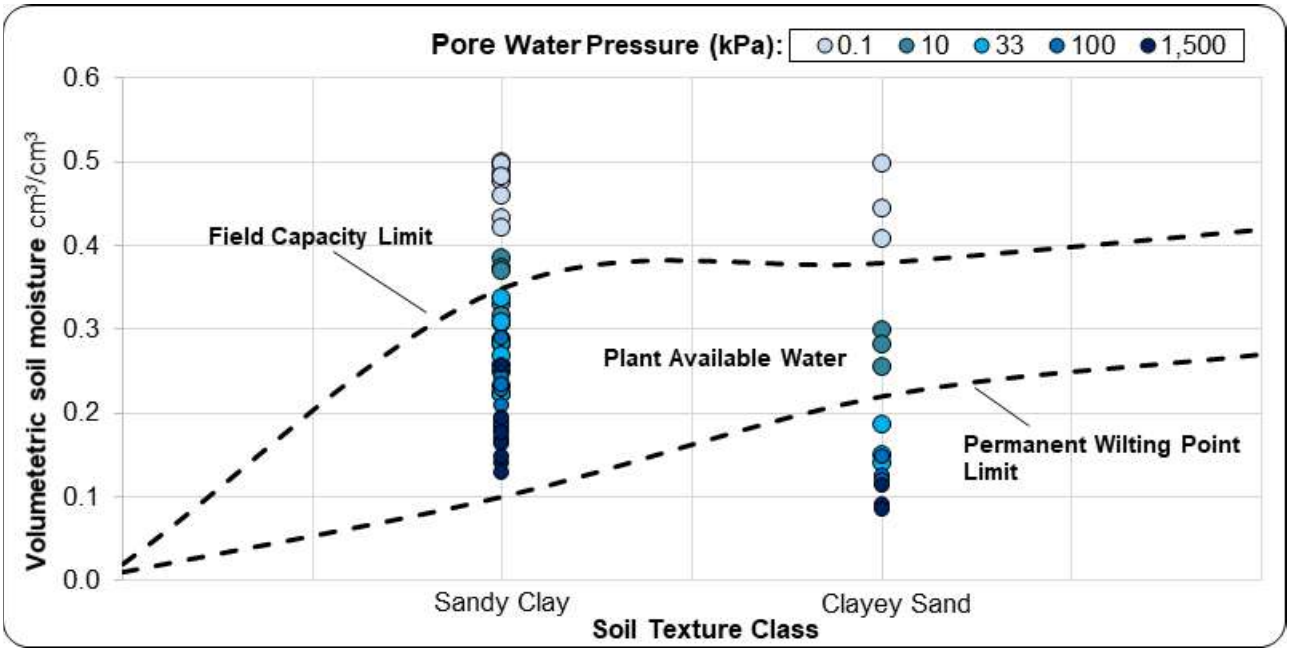


Figure 5-7. Graph of plant available water and soil texture class

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.

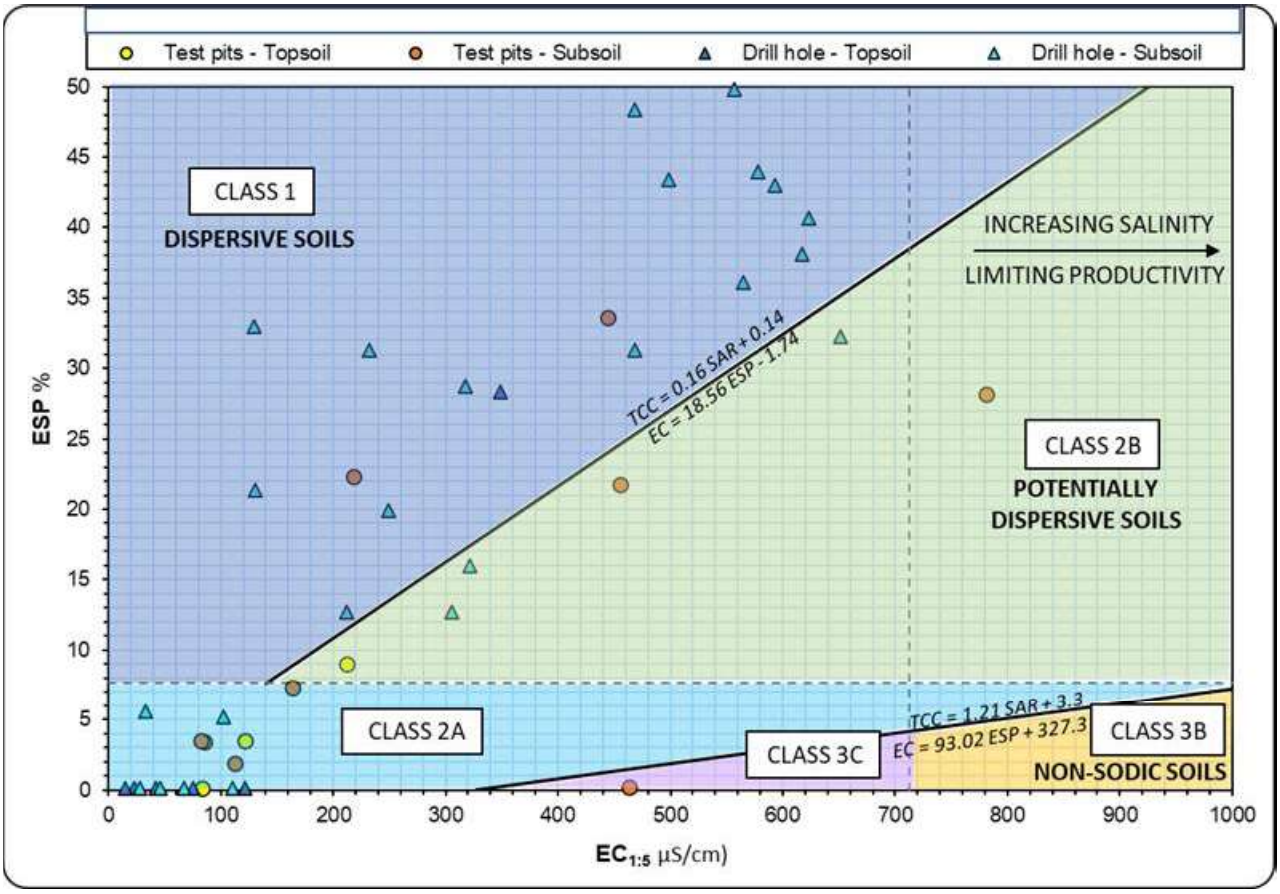


Figure 5-8: Rengasamy soil classification

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),'

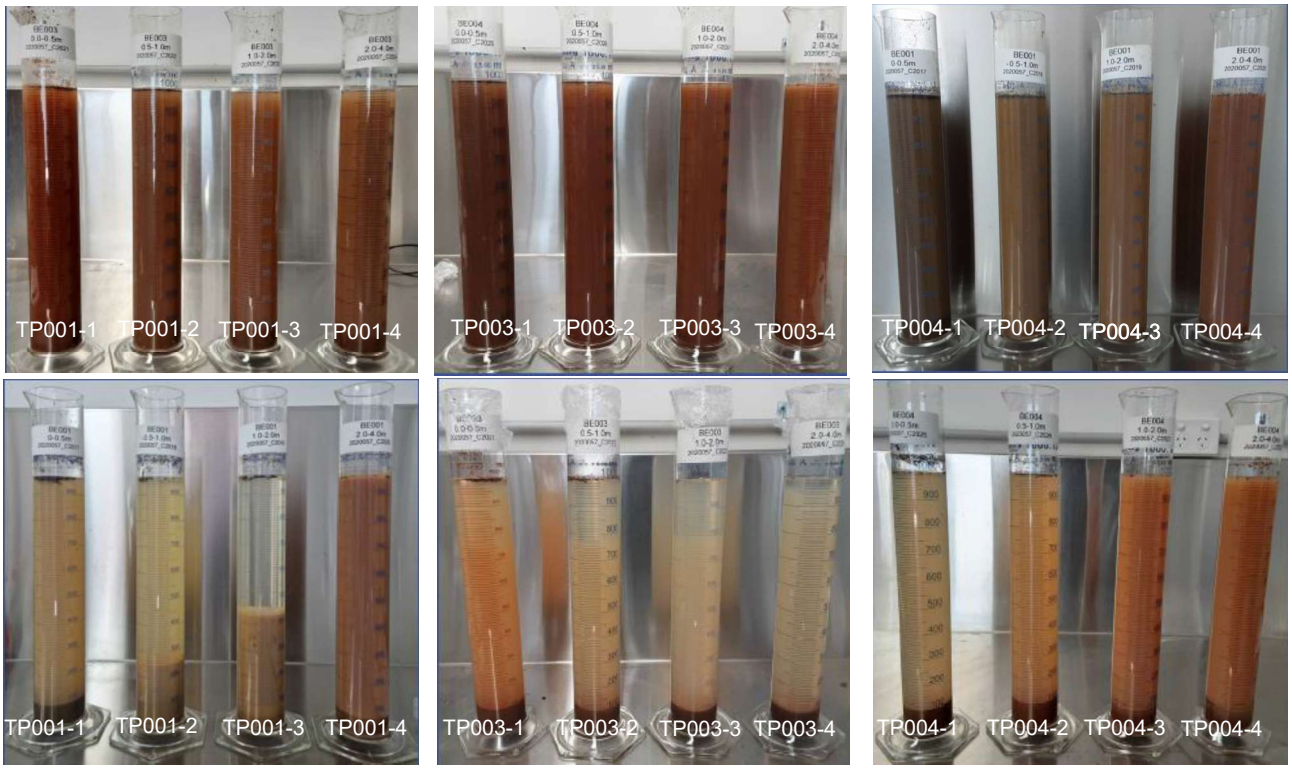


Figure 5-9: **Suspended sediment settlement at 0 hours (top) and 114 hours (bottom) for Topsoil, Subsoil#1, Subsoil#2 and regolith in TP001, TP003 and TP004 (left to right)**

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**.

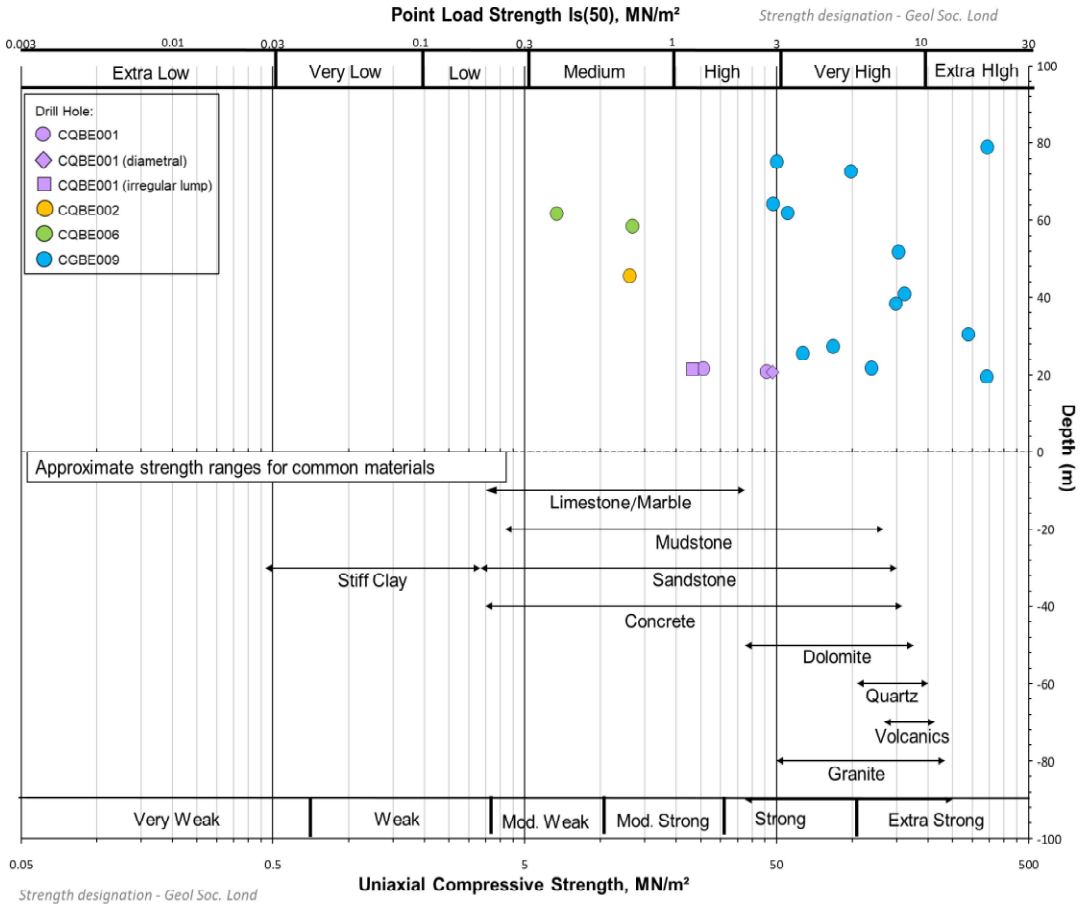


Figure 5-10. Point load strength of overburden materials compared to standard materials

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).

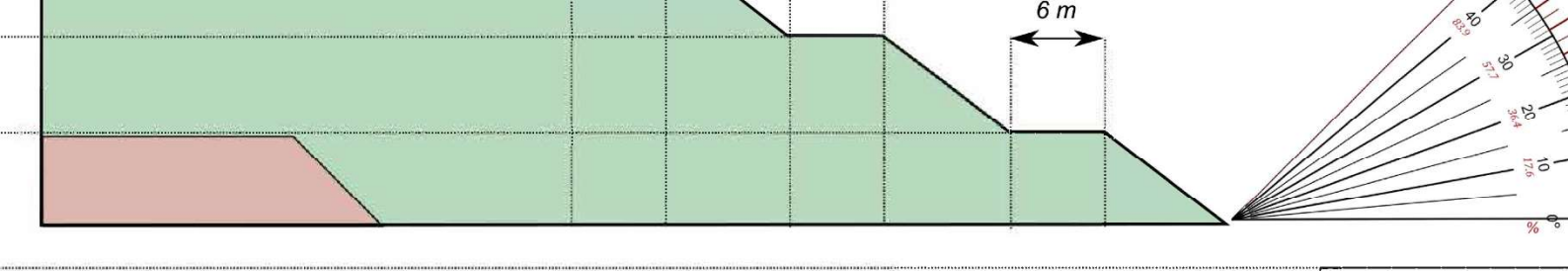
Detailed landform designs integrated with the mining schedule will enable the projected final landform surface to be defined. Throughout the mine life, material can be placed on the contact of the final landform surface to attain final landform design principles i.e. deep layers of regolith units could 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.,

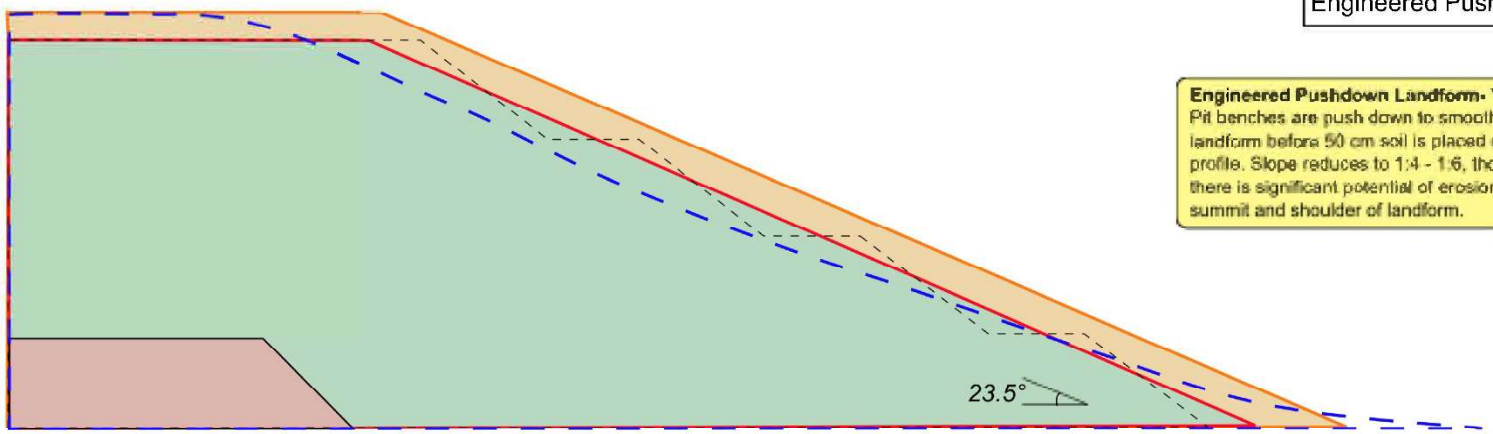
- 2 m of regolith material could be placed on the summit,
- 5 m of regolith material could be placed on the shoulder,

- 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.

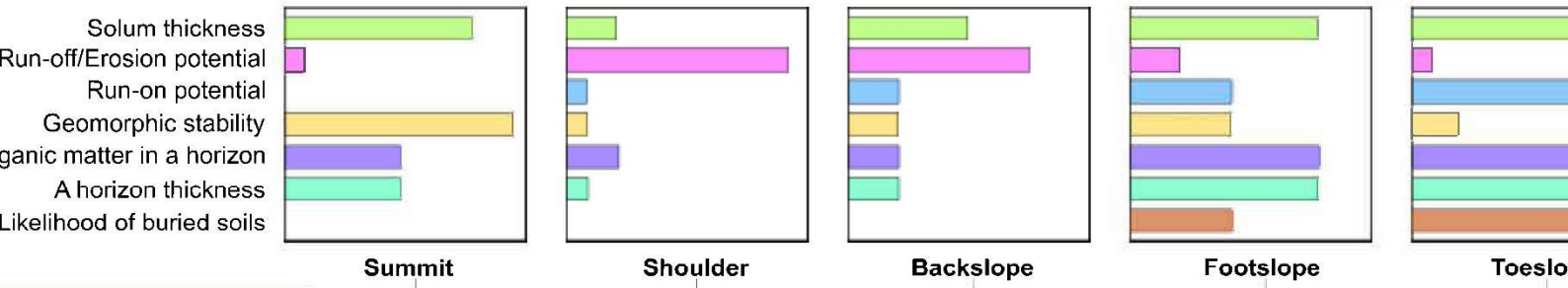


Engineered Pushdown



Engineered Pushdown Landform- Year 1
Pit benches are push down to smooth landform before 50 cm soil is placed on top o profile. Slope reduces to 1:4 - 1:6, though there is significant potential of erosion from summit and shoulder of landform.

Proposed Engineered

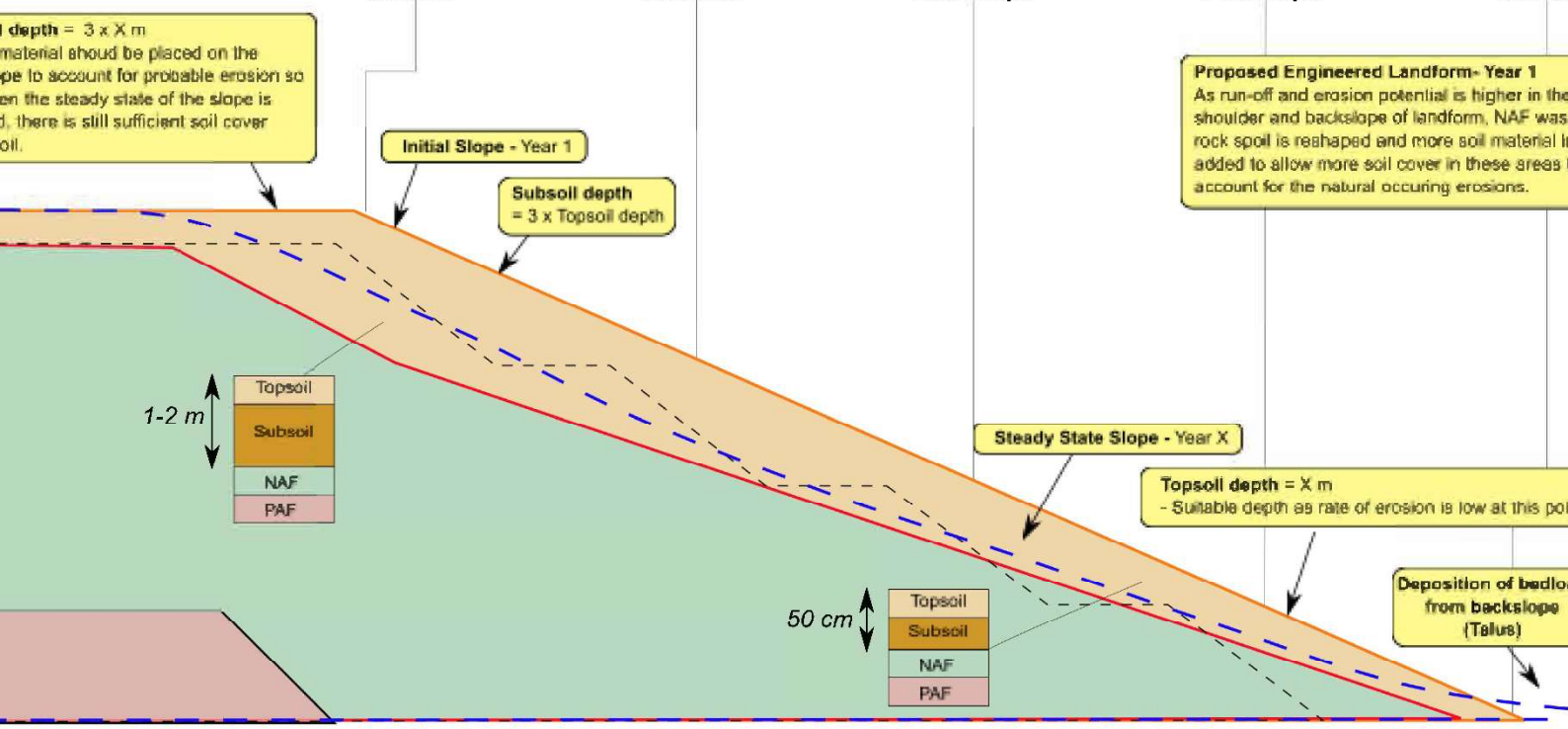


depth = 3 x X m
material should be placed on the pe to account for probable erosion so en the steady state of the slope is d, there is still sufficient soil cover oil.

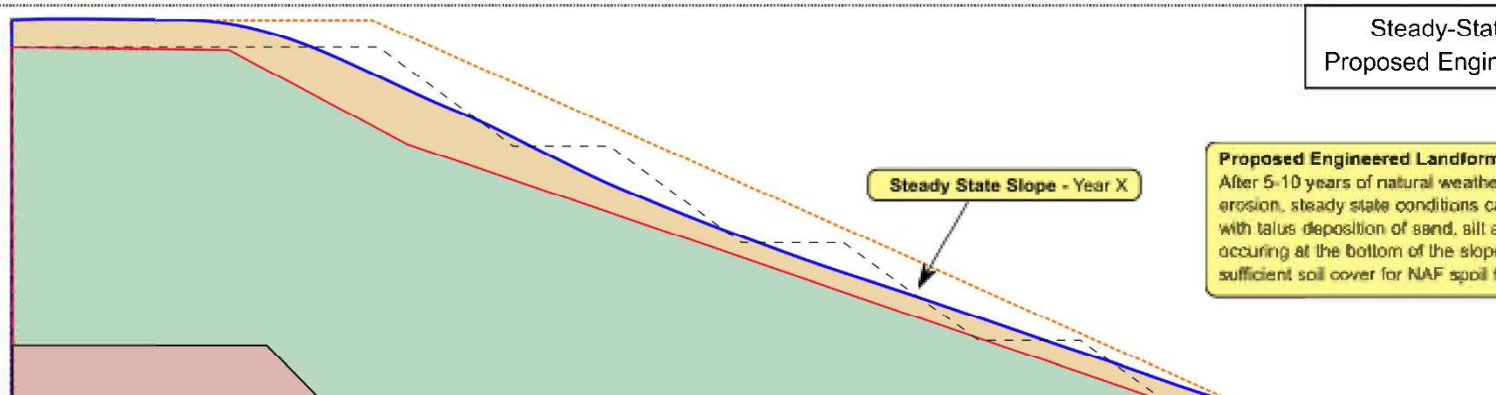
Initial Slope - Year 1

Subsoil depth
= 3 x Topsoil depth

Proposed Engineered Landform- Year 1
As run-off and erosion potential is higher in the shoulder and backslope of landform, NAF was rock spoil is reshaped and more soil material i added to allow more soil cover in these areas account for the natural occuring erosions.



Steady-State Co
Proposed Engineered



Proposed Engineered Landform- Year
After 5-10 years of natural weathering an erosion, steady state conditions can be a with talus deposition of sand, silt and fine occuring at the bottom of the slope, allow sufficient soil cover for NAF spoil for reve

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.

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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:

$$KFe_3(OH)_6(SO_4)_2 + 3OH^- \rightarrow 3Fe(OH)_3 + 2SO_4^{2-} + K^+$$

Acidity that is buffered through protonation of variably charged particles can be released through their de-protonation, e.g.:

$$[Al(OH)]SO_4 + 2OH^- \rightarrow Al(OH)_3 + SO_4^{2-}$$

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

001	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	
001	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	
001	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	
001	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	
001	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	
002	Roof	9	414	0.07	0.05	67	0.05	2.1	1.4	266	-263.9	-264.6	124.1	184.8	
002	Roof	9	440	0.28	0.18	65	0.18	8.6	5.6	18.8	-10.2	-13.2	2.2	3.4	
002	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	
002	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	
002	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	
002	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	
003	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	
003	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	
003	Roof	9	348	0.25	0.19	74	0.19	7.7	5.7	28.4	-20.7	-22.7	3.7	5.0	
003	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	
003	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	
003	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	
003	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	
003	Coal	8.9	811	0.87	0.75	86	0.75	26.6	22.8	109	-82.4	-86.2	4.1	4.8	
003	Coal	8.9	561	1.08	0.89	83	0.89	33.1	27.3	112	-78.9	-84.7	3.4	4.1	
003	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	
004	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	
004	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	
004	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	
006	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	
006	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	
006	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	
008	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
008	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	
008	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	
es	Roof	8.4	383	0.33	0.24	72	0.24	10.1	7.3	150	-139.9	-142.7	14.8	20.7	
es	Floor	9	429	0.23	0.16	67	0.16	7.0	4.7	10	-3.0	-5.3	1.4	2.1	

Drill Hole

001	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	
001	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	
001	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	
001	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	
001	Siltstone	9	601	0.005	0.01	140	0.01	0.2	0.2	90.2	-90.2	-90.0	589.1	420.8	
001	Siltstone	8.9	565	0.03	0.01	43	0.01	0.9	0.4	41	-40.1	-40.6	44.6	103.0	
001	Sandstone	9	404	0.02	0.02	100	0.02	0.6	0.6	152	-151	-151.4	248.2	248.2	
001	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	
002	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	
002	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	
002	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	
002	Siltstone	8.9	591	0.01	0.01	90	0.01	0.3	0.3	82.3	-82	-82.0	268.7	298.6	
002	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	
002	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	
002	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	
002	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	
002	Claystone	8.8	456	0.005	0.01	260	0.01	0.2	0.4	254	-254	-253.6	1658.8	638.0	
002	Siltstone	8.8	622	0.02	0.01	65	0.01	0.6	0.4	37	-36.4	-36.6	60.4	92.9	
002	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	
002	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	

003	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	
003	Siltstone	8.4	413	0.005	0.0025	50	0.0025	0.2	0.1	117	-117	-116.9	764.1	1528.2	
003	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	
003	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	
003	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	
003	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	
004	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	
004	Silt	8	340	0.01	0.01	100	0.01	0.3	0.3	7.6	-7.3	-7.3	24.8	24.8	
004	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	
004	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	
004	Siltstone	7.9	730	0.02	0.01	50	0.01	0.6	0.3	6.6	-6	-6.3	10.8	21.6	
004	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	
004	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	
004	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	
004	Siltstone	9	408	0.02	0.01	55	0.01	0.6	0.3	43	-42.4	-42.7	70.2	127.6	
004	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	
004	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	
004	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	
005	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	
005	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	
005	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	
005	Siltstone	8	358	0.01	0.01	90	0.01	0.3	0.3	6.1	-5.8	-5.8	19.9	22.1	
005	Siltstone	8.2	392	0.01	0.01	90	0.01	0.3	0.3	6	-5.7	-5.7	19.6	21.8	
005	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	
005	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	
005	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	
005	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	
005	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	
005	Sandstone	9	362	0.02	0.01	65	0.01	0.6	0.4	58	-57.4	-57.6	94.7	145.7	
005	Siltstone	8.5	330	0.02	0.03	125	0.03	0.6	0.8	61	-60.4	-60.2	99.6	79.7	
005	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	
005	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	
005	Coal	6.9	1210	1.52	0.70	46	0.70	46.6	21.4	19	27.5	2.4	0.4	0.9	
005	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
006	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	
006	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	
007	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	
007	Siltstone	5.9	73	0.03	0.01	33	0.01	0.9	0.3	1.9	-1	-1.6	2.1	6.2	
007	Siltstone	6	72	0.01	0.01	100	0.01	0.3	0.3	1.5	-1.2	-1.2	4.9	4.9	
007	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	
007	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	
007	Siltstone	6	172	0.02	0.01	65	0.01	0.6	0.4	3.2	-2.6	-2.8	5.2	8.0	
007	Siltstone	8	336	0.02	0.01	65	0.01	0.6	0.4	31.9	-31.3	-31.5	52.1	80.1	
007	Siltstone	8.3	234	0.03	0.02	67	0.02	0.9	0.6	46	-45.1	-45.4	50.1	75.1	
007	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	
007	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	
007	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	
007	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	
007	Coal	7.7	1100	1.75	1.34	77	1.34	53.6	41.0	37	16.6	4.0	0.7	0.9	

vided for 1:5 sample:water extracts

; ANC = Acid Neutralising Capacity; and NAPP = Net Acid Producing Potential.

il provided in report text.

9.2.2 Table B2: Multi-element test results

	All units mg/kg										
50	18400	15600	35300	13400	18900	14600	8700	4200	23100	13900	7000
50	5600	5200	5500	2800	5900	5200	4500	4000	4700	4800	5700
50	1400	1200	1500	1500	1400	1400	1200	2200	1400	1400	2000
50	1600	1200	1000	900	1200	1100	1200	1300	400	700	800
	All units mg/kg										
50	14100	12500	9900	17000	17100	14000	14700	12300	19200	14100	14300
0.1	0.17	0.28	0.23	0.46	0.47	0.26	0.47	0.89	0.23	0.28	0.79
0.1	3.4	6.8	10.8	7.8	17.2	7.4	21.7	13.6	7.1	10.1	22.9
0.1	170	110	160	160	50	40	290	350	110	130	100
0.1	0.87	1.22	1.14	0.83	0.91	1.06	1.13	1.07	0.82	1.17	1.23
0.1	0.19	0.28	0.22	0.14	0.19	0.41	0.43	0.4	0.15	0.38	0.37
50	10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10
0.1	0.07	0.11	0.09	0.02	0.05	0.15	0.12	0.12	0.07	0.11	0.1
0.05	1.47	1.56	2.07	1.65	1.82	2.05	1.98	4.91	1.46	2.12	5.58
0.01	16.1	15.8	19.35	15.2	9.94	17.05	21.7	9.02	15	15	14.75
0.1	19	15	12	34	20	15	16	10	25	15	11
0.1	13.7	15.6	12.9	10.2	16.6	14.9	13.9	7.6	16.7	16.6	13.2
0.1	23.9	34.5	32.5	18.9	29.1	53.2	52	49.5	19.7	48.4	45.5
0.05	4.57	4.98	3.65	6.3	6.48	5.15	6.62	3.79	7.09	6.1	4.62
0.05	0.06	0.07	0.06	0.05	0.06	0.07	0.07	<0.05	0.05	0.06	0.05
-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
0.1	0.14	0.18	0.15	0.12	0.14	0.17	0.2	0.13	0.11	0.17	0.14
0.005	0.033	0.05	0.047	0.03	0.036	0.055	0.08	0.052	0.034	0.054	0.06
50	31500	45000	43300	32000	39000	30400	31200	20400	35400	37400	56000
0.5	6.3	6	7.1	6.4	3.8	6.9	8.7	3.5	5.8	5.8	5.2
0.1	12.6	19.1	17.2	10.1	15.5	25.6	25.3	19.1	12.5	20.7	20.4
0.1	7.4	9.2	7.7	7.3	12.7	9.3	11.8	10.3	9.5	10.1	13.9
0.1	609	671	944	441	692	665	656	298	881	717	1200
0.005	0.01	0.01	0.05	0.01	0.01	0.02	0.05	0.12	0.01	0.02	0.11
0.1	0.13	0.38	0.5	0.3	0.43	0.33	0.83	1.31	0.15	0.45	1.04
0.1	20.6	22.7	18.7	18.7	28.5	24.1	22.7	17.2	21.9	25.2	20.3
0.1	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05
10	320	840	830	150	430	530	730	340	230	670	880
0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
0.1	12.7	8.1	9.6	18.5	9.6	10	8	14.6	14.5	10.4	14.6
0.1	5.8	7.5	8.2	5.5	6.6	7.2	7.4	4.6	7.1	7.5	6.4
1	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.6	0.3	0.3	0.6
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	88.6	92.9	168.5	49.9	90.7	96.8	88.4	74.6	74.9	83.6	104
100	100	200	300	100	100	200	300	1700	100	200	1000
0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
0.05	0.04	0.05	0.04	0.03	0.04	0.06	0.08	0.07	0.03	0.06	0.06
0.1	3.6	3.9	3.9	2.5	2.8	3.8	4.6	2.4	2.5	3.4	3.8
0.005	<0.005	<0.005	<0.005	50	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
0.1	0.08	0.05	0.06	0.13	0.06	0.06	0.04	0.02	0.1	0.07	0.04
0.1	0.8	0.8	0.6	0.7	0.8	0.9	1.2	0.7	0.8	0.9	0.7
0.1	0.18	0.08	<0.05	0.24	0.13	0.05	<0.05	<0.05	0.15	<0.05	<0.05
0.1	0.49	0.57	0.41	0.29	0.39	0.54	0.6	0.38	0.44	0.54	0.44
1	45	45	44	61	44	36	40	24	57	39	31
0.1	8.88	10.35	11	8.09	8.95	9.46	11.1	4.94	9.94	10.75	8.45
0.5	54	81	71	31	66	84	86	83	53	82	82
0.5	4.9	7	6.3	4.7	4.7	6	6.9	5.1	4	6.2	4.3
5	54	81	71	31	66	84	86	83	53	82	82

50	8300	23400	15600	9200	1100	15600	17400	21100	5200	8100	5000	
50	6000	5000	5800	3700	1600	4400	5600	5600	4800	2200	2100	
50	2200	1600	1800	1400	800	1700	1400	1800	1800	1300	1200	
50	2100	1000	1000	1000	1100	900	600	600	600	400	400	
50	22500	18400	17400	14300	9400	17400	14500	17100	11300	8000	6900	
0.1	0.37	0.2	0.13	0.57	0.25	0.24	0.25	0.16	0.86	0.43	0.32	
0.1	7.6	4.4	2.8	18.7	7	7.3	9.5	8	17.8	7.9	6.2	
0.1	400	100	100	160	190	100	80	50	120	70	100	
0.1	1.22	0.89	1.35	1.52	0.86	0.92	1.15	0.95	1.17	0.69	0.54	
0.1	0.28	0.16	0.37	0.47	0.1	0.16	0.3	0.19	0.38	0.26	0.26	
50	10	<10	<10	<10	10	10	<10	<10	<10	<10	<10	
0.1	0.09	0.08	0.12	0.13	<0.01	0.05	0.14	0.08	0.1	0.08	0.08	
0.05	1.81	1.44	2.4	3.11	1	1.33	1.6	1.46	4.28	2.06	1.89	
0.01	13.65	11.25	17.95	17.1	14.95	12.6	15.35	11.15	14.9	8.91	8.5	
0.1	20	21	16	12	90	27	18	20	12	7	8	
0.1	17.6	16.6	17	14.7	11.2	15.6	17	16.4	14.7	8.4	6.8	
0.1	41	23.3	44.5	48.9	19.7	22.4	43	27.6	46.8	36.6	36.3	
0.05	7.84	6.58	6.45	5.05	3.98	6.37	5.85	5.38	4.1	2.08	1.64	
0.05	0.06	0.06	0.07	0.06	0.08	0.06	0.06	0.05	0.06	0.06	<0.05	
-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
0.1	0.16	0.14	0.15	0.16	0.18	0.13	0.16	0.14	0.13	0.12	0.1	
0.005	0.041	0.036	0.049	0.074	0.032	0.033	0.047	0.034	0.055	0.05	0.043	
50	42300	39400	40700	38200	63300	38100	43300	37400	50600	36700	17400	
0.5	4.7	3.8	6.8	6.6	6.6	4.6	5.7	4.1	5.3	3.2	3.2	
0.1	16.3	10.9	29.6	26.7	9	11.5	20	14.4	19.3	11.9	11.4	
0.1	13.8	9.4	10.6	12	2.7	10.4	9.4	9.6	9.5	6.3	5.3	
0.1	702	816	870	825	313	640	770	749	1040	528	303	
0.005	0.01	<0.01	0.01	0.07	<0.01	0.01	0.03	0.01	0.07	0.07	0.07	
0.1	0.25	0.1	0.18	1.15	1.07	0.25	0.52	0.22	1.33	1.92	1.21	
0.1	25.3	24.8	25.9	20	23.4	24.6	23.4	24.4	22.2	14.6	12.1	
0.1	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
10	850	450	910	1160	160	360	750	440	1080	2440	1420	
0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	
0.1	14.9	10.6	12.9	9.9	11	12.6	9.3	11.4	12.4	7.9	6.9	
0.1	7.4	7	8.2	6.8	5.1	6.6	7.6	6.4	6	5.1	3.8	
1	0.3	0.2	0.3	0.4	0.4	0.2	0.2	0.2	0.6	0.8	0.6	
0.1	0.03	0.05	0.1	0.09	0.02	0.03	0.07	0.06	0.09	0.05	0.05	
0.1	52.8	86.7	131.5	128.5	27.8	63.6	103	100.5	78.8	92.7	71.7	
100	300	1100	200	400	200	100	200	300	1600	10300	5900	
0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
0.05	0.04	0.04	0.05	0.08	0.03	0.03	0.05	0.03	0.06	0.06	0.06	
0.1	3.4	2	2.8	4.4	3.5	2.5	3.7	2.3	4.3	2.1	2.1	
0.005	<0.005	<0.005	<0.005	<0.005	140	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	
0.1	0.08	0.07	0.07	0.04	0.06	0.06	0.06	0.07	0.04	<0.02	<0.02	
0.1	0.9	0.7	0.9	1.1	0.5	0.8	0.8	0.7	0.7	0.5	0.4	
0.1	0.06	0.11	<0.05	<0.05	0.51	0.53	0.07	0.37	0.06	0.09	0.06	
0.1	0.5	0.33	0.56	0.66	0.36	0.41	0.48	0.34	0.52	0.45	0.36	
1	49	46	38	34	111	54	44	44	31	23	19	
0.1	13.9	10.7	13.85	11.1	8.31	9.57	9.87	8.91	10.65	10.15	6.56	
0.5	79	63	79	86	31	57	82	69	83	52	52	
0.5	5.2	4.2	5.4	6.2	6.9	4.6	6.3	4.5	4.7	4.5	3.5	
5	79	63	79	86	31	57	82	69	83	52	52	

50	5200	300	8700	19500	14600	6300	3700	16700	25100	26000	2200
50	4800	200	3200	5100	5400	5600	3000	900	4500	1900	3900
50	2400	300	1400	1300	2700	2300	1700	500	2000	400	2400
50	500	200	600	400	400	400	400	200	1200	800	2100
50	13700	7400	12700	14000	16500	13800	10100	4300	13600	5700	11500
0.1	0.9	0.35	0.12	0.26	0.56	0.95	0.54	0.14	0.82	0.13	0.24
0.1	12	9.2	6	11.2	18.1	20.5	11.4	2.3	14.8	1.5	4.9
0.1	140	140	270	110	130	130	110	50	330	300	1160
0.1	1.07	0.21	1.32	1.19	1.29	1.32	0.81	0.38	1.17	0.39	1.02
0.1	0.44	0.12	0.16	0.28	0.28	0.35	0.33	0.14	0.4	0.13	0.36
50	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
0.1	0.14	<0.01	0.08	0.08	0.08	0.09	0.11	0.04	0.13	0.05	0.13
0.05	3.53	0.48	1.98	1.32	3.32	4.15	4.42	0.82	5	0.53	4.7
0.01	11.8	4.17	21.3	15.25	18.6	19.35	8.2	6.45	13.45	8.72	7.81
0.1	11	45	17	17	13	11	9	3	10	6	8
0.1	20.5	1.8	27.1	14.5	14.7	13.8	12.8	2.5	13.2	5	9.1
0.1	55.9	14.9	25.1	32.5	42.5	45.4	45.4	19.4	50.7	22	58.1
0.05	4.68	3.11	4.73	5.26	5.41	4.57	2.63	0.98	4.13	1.16	3.57
0.05	0.05	0.05	0.07	0.06	0.06	0.07	<0.05	0.08	0.06	0.09	<0.05
-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
0.1	0.13	0.1	0.11	0.16	0.13	0.13	0.11	0.09	0.12	0.08	0.09
0.005	0.064	0.037	0.032	0.053	0.053	0.055	0.056	0.024	0.061	0.026	0.05
50	42600	50200	34200	43200	45200	56900	12000	17200	26500	28200	11600
0.5	4.2	1.6	5.9	5.5	6.7	7	3	2.4	4.9	3.4	3.5
0.1	26.3	4	11.5	21.8	17.9	19.5	17.6	4.7	20.5	4.4	16.7
0.1	10.6	2.1	8.7	7.6	10.6	9.6	9.3	3.3	11.5	4.8	8.4
0.1	764	25	833	768	733	1270	123	234	492	518	102
0.005	0.12	0.01	0.01	0.03	0.05	0.08	0.09	0.03	0.11	0.31	0.23
0.1	2.71	3.08	0.2	0.59	0.88	1.4	0.92	0.82	2.11	0.74	1.18
0.1	34.4	3.6	30.1	21.2	23.2	23.9	19.9	4.4	21	10.9	18.9
0.1	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05
10	960	170	380	760	1190	1350	1030	1840	2360	2390	270
0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	<0.001
0.1	13.2	3.5	12.8	8.8	16.7	15	11.2	3.6	13.5	2.3	14
0.1	5.6	4.8	6.6	7.7	7.3	7.2	5.1	2.5	6.1	3.1	3.6
1	0.8	0.9	0.4	0.3	0.4	0.6	0.8	0.5	0.8	0.6	0.6
0.1	0.11	0.01	0.03	0.06	0.08	0.09	0.08	0.02	0.11	0.02	0.09
0.1	77	6	30.9	85.5	90.3	76.3	75.1	92.5	159.5	154	154
100	4000	200	200	200	500	1200	2800	19000	2000	5500	2200
0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
0.05	0.09	0.03	0.02	0.05	0.05	0.06	0.06	0.03	0.07	0.03	0.07
0.1	4.4	2.3	2.3	3.4	4.6	4.4	2.2	1.4	5.2	1.3	1.6
0.005	<0.005	80	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
0.1	0.04	0.02	0.07	0.05	0.05	0.05	<0.02	<0.02	0.02	<0.02	0.07
0.1	0.7	0.4	0.7	0.9	0.7	0.7	0.6	0.3	0.7	0.3	0.5
0.1	<0.05	0.23	0.49	0.09	0.12	0.05	<0.05	0.09	<0.05	<0.05	<0.05
0.1	0.47	0.33	0.47	0.49	0.6	0.55	0.34	0.29	0.94	0.3	0.31
1	32	205	43	52	38	33	24	10	26	13	18
0.1	10.25	1.15	13.9	10.15	13.1	14.05	6.89	5.85	13.1	8.13	3.47
0.5	99	40	74	76	86	85	75	18	84	21	70
0.5	4.2	3.9	3.8	5.8	5.4	5.2	3.7	3.1	4.1	3.1	3.1
5	99	40	74	76	86	85	75	18	84	21	70

9.2.3 Table B3: Multi-element test results for water extracts

1 µS/cm	808	740	548	670	778	847	666	645	292	568	484	867	940
1 mg/L	0	3	5	0	0	1	1	0	0	0	0	0	0
1 mg/L	28	21	23	28	17	22	22	20	17	17	24	30	32
1 mg/L	28	24	28	28	17	23	23	20	17	17	24	30	32
1 mg/L	1	0	0	0	0	0	0	0	0	0	0	0	0
1 mg/L	28	24	28	28	17	23	23	20	17	17	24	30	32
										All units mg/L			
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
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
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
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
2	33.2	28	12.6	22.8	36.8	37.6	22	11	7.6	21.6	2.2	32.6	33.8
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
2	3.4	6	7	3.8	3	5.6	8.4	24.6	0.2	4.6	20	6.8	11.6
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
0.002	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
0.02	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
0.02	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
0.002	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
0.002	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
										All units mg/L			
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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.05	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
0.0001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.01	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	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
0.001	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
0.05	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.0001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.01	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	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
0.001	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
0.005	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.01	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
0.001	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
0.01	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

1 µS/cm	496	452	428	497	383	390	499	1380	1130	413	729	122	383
1 mg/L	3	2	0	1	1	2	0	0	0	0	0	0	0
1 mg/L	34	23	14	24	24	21	23	6	6	14	21	1	21
1 mg/L	37	26	14	25	25	23	23	6	6	14	21	1	21
1 mg/L	0	0	0	0	0	0	1	1	1	0	0	0	0
1 mg/L	37	26	14	25	25	23	23	6	6	14	21	1	21
													All units mg/L
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
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
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
2	22	19.8	16.6	19.8	16.2	16.4	15.2	9	8.4	23	15.6	4.2	11.4
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
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
2	3.6	12.4	3.4	2.6	5.2	4.8	20	153.8	121	19.2	49.4	2	5.4
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
0.002	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
0.02	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
0.02	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
0.002	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
0.002	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
													All units mg/L
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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.05	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
0.0001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.01	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	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
0.001	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
0.05	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.0001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.01	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
0.001	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
0.001	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
0.005	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
0.001	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
0.001	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
0.001	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
0.001	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
0.001	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
0.01	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
0.001	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
0.01	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

1 µS/cm	382	464	753	1340	658	627	549
1 mg/L	0	0	0	0	1	0	0
1 mg/L	23	26	11	9	24	16	16
1 mg/L	23	26	11	9	25	16	16
1 mg/L	0	0	0	1	0	0	0
1 mg/L	23	26	11	9	25	16	16
2	2	3	8.8	45.6	0.6	5.4	0.1
2	2.4	3.2	7	6.8	0.6	2.2	0.1
2	2.2	2.2	2.4	1.2	1	1	0.6
2	9.4	9.6	10.4	4.2	25.4	19.8	21
2	2.4	2.4	1.6	0.6	12.6	5.4	11.8
0.2	0.12	0.1	0.06	0.04	0.12	0.04	0.12
2	11.2	17.4	64.6	143.6	19.4	36.6	16.8
0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
0.002	0.348	0.001	0.224	0.001	0.004	0.002	0.012
0.02	0.04	0.02	0.04	0.01	0.04	0.04	0.1
0.02	0.38	0.02	0.26	0.01	0.04	0.04	0.12
0.002	0.002	0.001	0.001	0.001	0.006	0.004	0.024
0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.002
0.01	0.092	0.042	0.022	0.012	0.444	0.068	0.336
0.001	0.001	0.0008	0.0004	0.0001	0.003	0.0001	0.0016
0.001	0.0006	0.0002	0.0001	0.0001	0.0038	0.0001	0.025
0.001	0.22	0.204	0.0962	0.0098	0.1654	0.0214	0.1498
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.05	0.066	0.078	0.074	0.018	0.072	0.02	0.09
0.0001	0.00002	0.00004	0.00006	0.00001	0.00004	0.00001	0.00002
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0018	0.0001	0.0001	0.0001	0.0002	0.0001	0.0002
0.001	0.0001	0.0001	0.0016	0.0002	0.0001	0.0001	0.0001
0.001	0.0014	0.0028	0.0016	0.0001	0.0004	0.0001	0.001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.05	0.018	0.005	0.005	0.005	0.068	0.026	0.062
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0006	0.0012	0.0012	0.0001	0.0008	0.0001	0.0012
0.001	0.0014	0.002	0.0064	0.0024	0.0016	0.0034	0.0014
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.003	0.0096	0.03	0.0454	0.001	0.005	0.0006
0.0001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
0.001	0.01	0.0138	0.0026	0.0008	0.0604	0.0086	0.0454
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0002	0.0002	0.0024	0.0002	0.0001	0.0006	0.0001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0016	0.0016	0.0018	0.0008	0.0014	0.001	0.001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.01	0.004	0.004	0.012	0.001	0.012	0.001	0.016
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0816	0.1098	0.262	0.33	0.0294	0.3	0.0126
0.005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
0.01	0.004	0.001	0.001	0.001	0.008	0.004	0.012
0.001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001

9.2.4 Table B4: Soil fertility results

	0.2	5.5	2.6	3	1.6	12.1	8.8	7.4	6.3	5.5	5.4
	0.2	3.8	3.6	5.4	3.7	2.8	2.8	2.9	2.5	2	4
	0.2	0.6	0.2	0.3	<0.2	0.4	0.2	<0.2	<0.2	0.2	0.3
	0.2	1	1.8	3.4	2.8	<0.2	0.2	0.4	0.3	0.3	0.8
	0.2	10.9	8.2	12	8.3	15.3	12.1	10.8	9.1	8.1	10.5
	0.2	9	21.8	28.2	33.6	<0.2	1.9	3.4	3.5	3.5	7.3
	0.2	1.5	0.7	0.5	0.4	4.3	3.2	2.5	2.5	2.7	1.4
	0.2	6.4	14.5	20.5	0	6.4	12	0	0	8.3	13.7
	9	9.3	9	8.3	8.7	9.2	9.2	8.6	9	9.2	9.5
	212	781	444	83	112	85	82	121	164	218	463
	1	7.1	8.1	8.8	5.9	12.1	7.4	4.8	11.1	8.3	11.5
mg/kg)	100	340	188	166	195	211	182	173	160	144	170
	10	90	440	1110	630	10	20	20	10	40	80
	1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
	1	18.3	10.7	8.83	5.82	5.52	4.98	5.52	6.15	9.62	7.76
	1	11.1	6.52	3.73	1.98	6.44	4.98	2.92	3.54	5.76	3.8
	1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	0.1	0.7	0.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	0.1	8.3	5.3	1.6	0.4	0.9	1.6	0.4	0.3	6	2.5
	0.1	9	6.1	1.6	0.4	0.9	1.6	0.4	0.3	6	2.5
	20	830	460	310	180	<20	520	220	230	550	390
	20	840	470	310	180	<20	520	220	230	560	390
	2	237	245	227	224	172	253	365	410	231	261
	5	7	<5	<5	<5	<5	<5	<5	<5	<5	<5
	0.5	2.1	1	0.6	<0.5	1.3	0.9	<0.5	<0.5	1.1	0.6
	0.5	1.2	0.6	<0.5	<0.5	0.7	0.5	<0.5	<0.5	0.6	<0.5

oratory limit of reporting.

	All units meq/100g (except Exchangable Sodium Percentage (%))										
	0.2	<0.2	0.3	1.1	1.3	0.3	0.4	3.2	1.5	1.1	<0.2
	0.2	<0.2	3.4	5	5.4	3.8	3.2	1.6	2.9	4.6	2.4
	0.2	<0.2	<0.2	0.2	<0.2	<0.2	<0.2	0.4	0.2	<0.2	<0.2
	0.2	<0.2	1.5	3	4.2	3.1	2.8	0.2	0.9	2.7	2.3
	0.2	<0.2	5.4	9.3	11.1	7.3	6.5	5.3	5.6	8.6	4.7
	0.2		28.3	32.3	38.1	43	43.4	3	16	31.3	48.4
	0.2		<0.2	<0.2	<0.2	<0.2	<0.2	2	0.5	0.2	<0.2
	0.2		----	21	----	----	----	3.7	14.2	----	----
	9	4300	9.3	9.4	9.7	9.7	9.8	7.3	8.3	9.5	9.8
	212	2500	349	651	617	593	498	23	322	468	468
	1	9.4	5.9	4.9	9.1	6.4	4.1	3.3	8.2	8.4	6
mg/kg)	100	102	146	215	223	193	186	295	165	144	118
	10	460	200	740	650	630	430	<10	210	360	330
	1	<1.00	1.1	1.22	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
	1	5.23	5.11	6.34	4.39	4.13	5.1	10.9	5.44	4.99	6.58
	1	3.31	3.08	2.21	2.65	2.21	3.05	4.8	5.61	2.48	4.52
	1	<1.00	<1.00	1.46	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	0.3	<0.1
	0.1	0.7	0.4	1.9	0.9	0.1	0.9	0.5	1.2	0.7	0.5
	0.1	0.7	0.4	1.9	1.2	0.1	0.9	0.5	1.2	1	0.5
	20	190	180	180	370	250	230	350	330	160	140
	20	190	180	180	370	250	230	350	330	160	140
	2	227	108	118	440	374	380	139	121	98	290
	5	<5	<5	<5	6	<5	<5	<5	<5	<5	<5
	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	0.7	<0.5	<0.5
	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5

oratory limit of reporting.

	0.2	11.4	4.7	2.6	1.6	0.7	3.1	1.2	1	<0.2	<0.2
	0.2	6.5	3.9	2.8	3.7	2.3	1.6	2	3.8	3.5	3.4
	0.2	0.4	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	<0.2	<0.2
	0.2	0.6	0.5	0.3	0.8	0.4	0.3	0.9	2.7	2.8	3.4
	0.2	19	9.2	5.7	6.1	3.4	5.4	4.1	7.6	6.3	6.8
	0.2	3.2	5.6	5.2	12.7	12.7	6.2	21.4	36.1	44	49.8
	0.2	1.8	1.2	0.9	0.4	0.3	1.9	0.6	0.3	<0.2	<0.2
	0.2	15.6	----	----	----	----	4.9	----	----	----	----
	9	7.3	8.6	9.2	9.4	9.2	7.2	8.3	9.4	8.8	8
	212	75	33	102	212	305	42	130	565	578	557
	1	6.3	4.4	4.8	5.1	3.2	2.1	4.4	7.4	6.7	5.2
mg/kg)	100	222	160	187	162	133	195	<100	103	<100	116
	10	30	20	<10	120	310	30	110	470	780	840
	1	1.5	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
	1	20	4.56	4.62	4.71	6.47	17.9	7.7	6.24	6.02	6.56
	1	28.4	3.07	2.87	2.38	5.79	22	9.83	4.36	4.22	2.42
	1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
	0.1	2.1	0.4	0.6	<0.1	0.1	1.6	0.8	0.2	<0.1	<0.1
	0.1	2.2	0.4	0.6	<0.1	0.1	1.8	0.8	0.2	<0.1	<0.1
	20	620	170	150	160	110	310	190	160	90	80
	20	620	170	150	160	110	310	190	160	90	80
	2	145	265	333	296	316	195	173	133	176	222
	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	0.5	1.8	<0.5	<0.5	<0.5	<0.5	0.9	0.6	<0.5	<0.5	<0.5
	0.5	1	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5

oratory limit of reporting.

	All units meq/100g (except Exchangable Sodium Percentage (%))									
	0.2	3.2	2.2	1.6	1.7	1.8	0.4	0.2	0.2	0.2
	0.2	4.3	3.3	2.6	3.2	1.2	1.1	0.8	0.8	0.9
	0.2	0.3	<0.2	<0.2	<0.2	0.2	<0.1	<0.1	<0.1	<0.1
	0.2	1.9	2.8	2	2	<0.1	0.2	0.4	0.5	0.5
	0.2	9.8	8.5	6.2	6.9	3.4	3.4	2.3	2.1	2.6
	0.2	19.9	33	31.3	28.7	1.8	12.2	26.2	35.7	29.5
	0.2	0.8	0.6	0.6	0.5	1.5	0.4	0.2	0.2	0.2
	0.2	13.5	----	----	----	4.9	----	----	----	----
	9	9.3	8.9	8.9	9	6.4	5.2	5	4.8	5
	212	249	129	232	318	15	28	46	110	67
	1	6.3	4.2	4.4	4.2	4.5	3.3	1.8	2.3	2.2
mg/kg)	100	154	140	118	165	164	<100	<100	<100	<100
	10	60	110	280	410	10	20	50	130	90
	1	<1.00	<1.00	<1.00	<1.00	1.34	<1.00	<1.00	<1.00	<1.00
	1	5.26	7.84	4.82	5.29	14.3	8.98	10.2	11.8	11
	1	4.29	4.45	3.63	4.83	2.5	1.69	1.03	1.4	1.42
	1	<1.00	1.33	<1.00	<1.00	16.4	1.43	<1.00	<1.00	<1.00
	20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
	0.1	0.6	0.8	0.3	0.7	1.3	<0.1	<0.1	<0.1	<0.1
	0.1	0.6	0.8	0.3	0.7	1.4	<0.1	<0.1	<0.1	<0.1
	20	130	160	80	200	300	50	<20	40	30
	20	130	160	80	200	300	50	<20	40	30
	2	80	129	81	114	98	109	49	60	58
	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	0.5	<0.5	<0.5	<0.5	<0.5	1.1	0.7	<0.5	0.5	<0.5
	0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5

oratory 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 (¼in.).
- 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**.

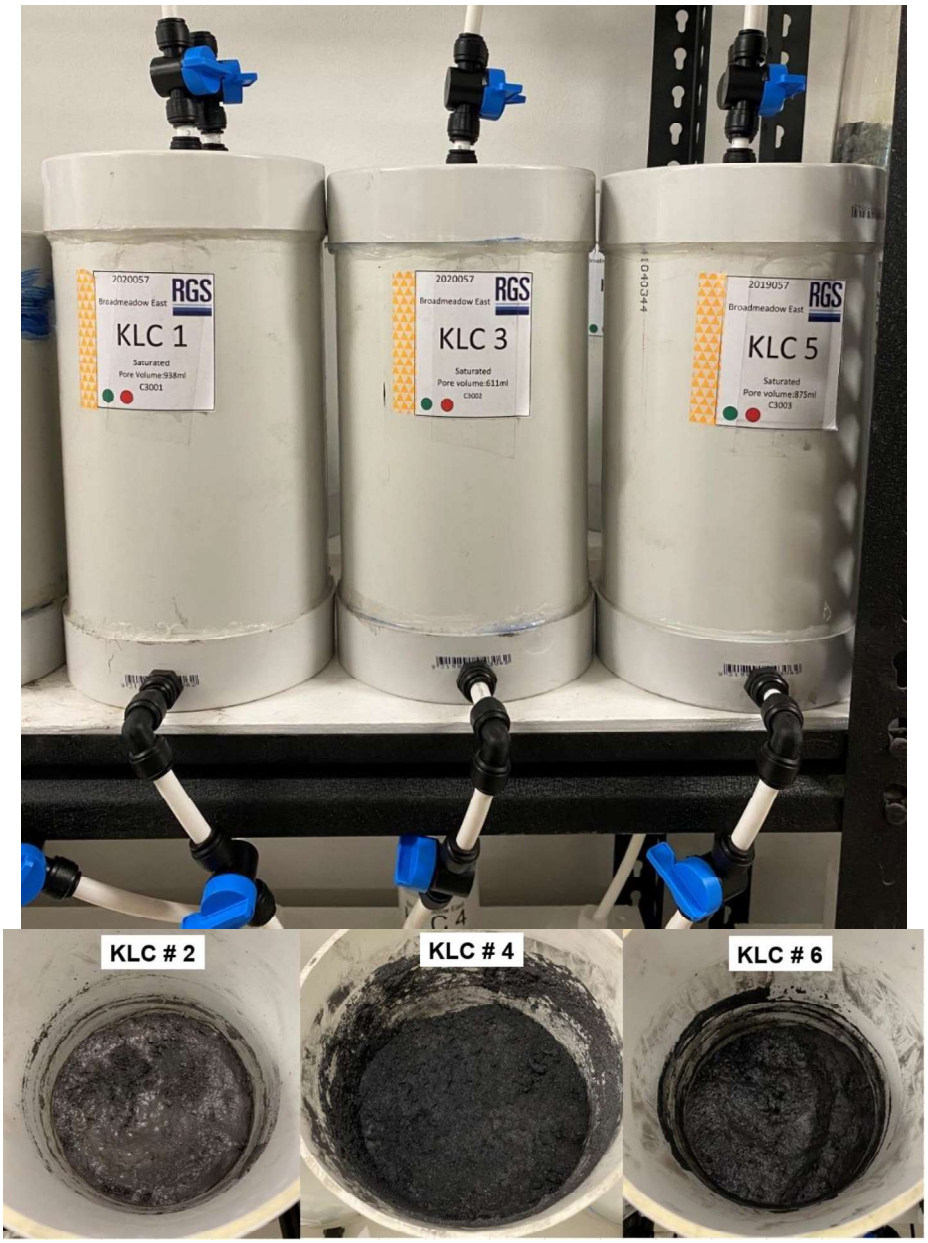
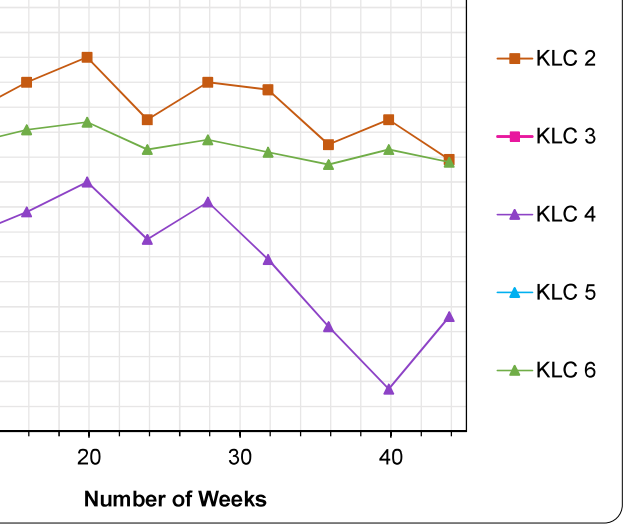
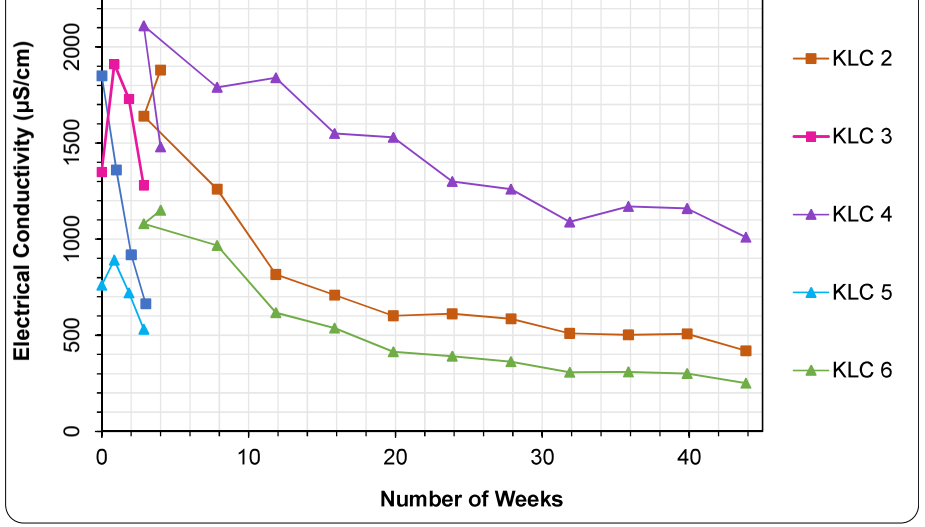
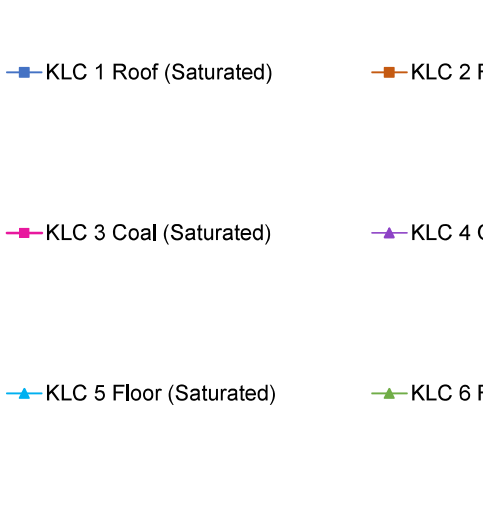
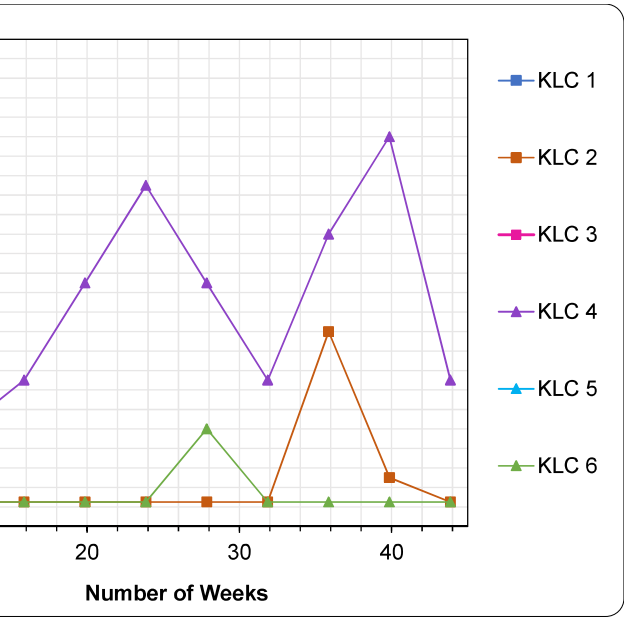


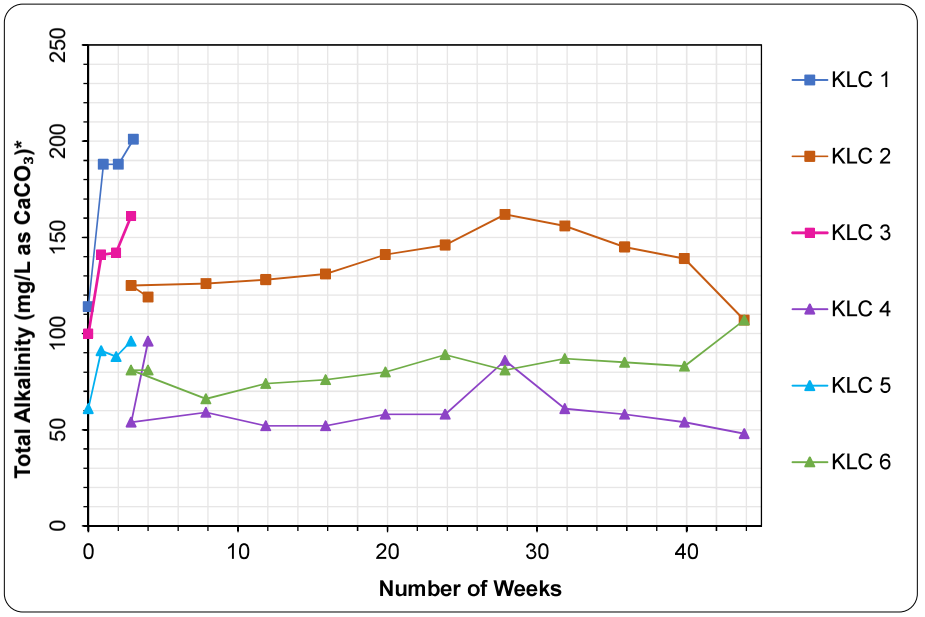
Figure 9-1. Broadmeadow East columns

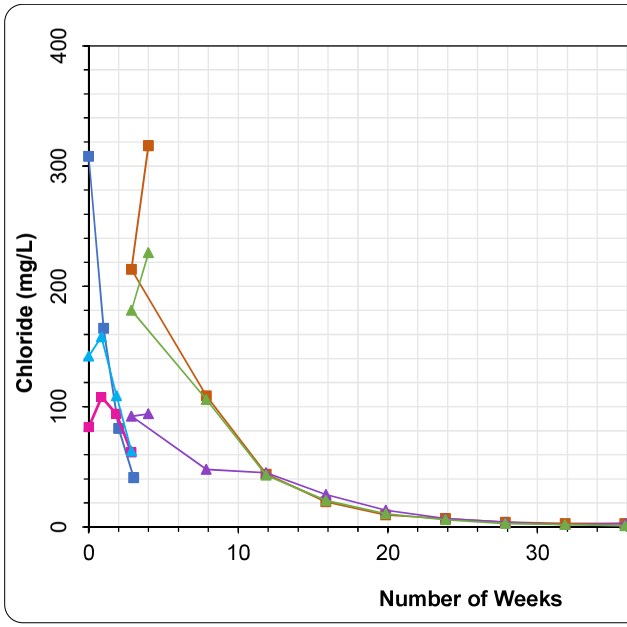

KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

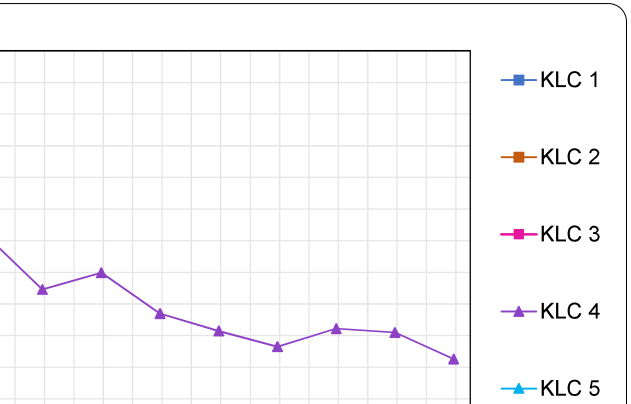

Electrical Conductivity (µS/cm)
0
500
1000
1500
2000
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
0
10
20
30
40
Number of Weeks

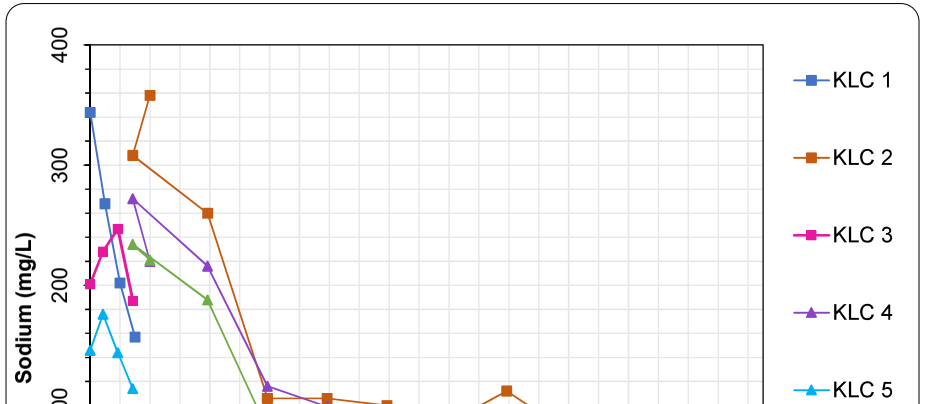

KLC 1 Roof (Saturated)
KLC 2 F
KLC 3 Coal (Saturated)
KLC 4 C
KLC 5 Floor (Saturated)
KLC 6 F

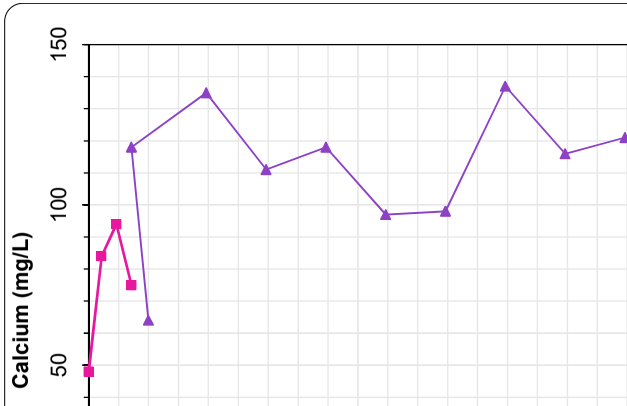

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

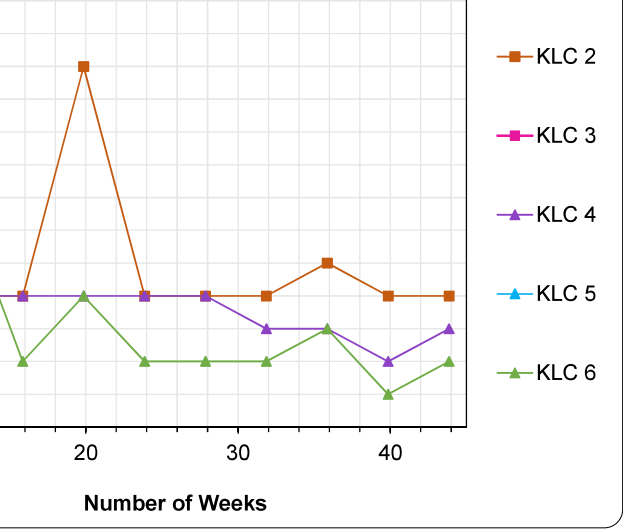

Total Alkalinity (mg/L as CaCO3)*
0
50
100
150
200
250
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
0
10
20
30
40
Number of Weeks

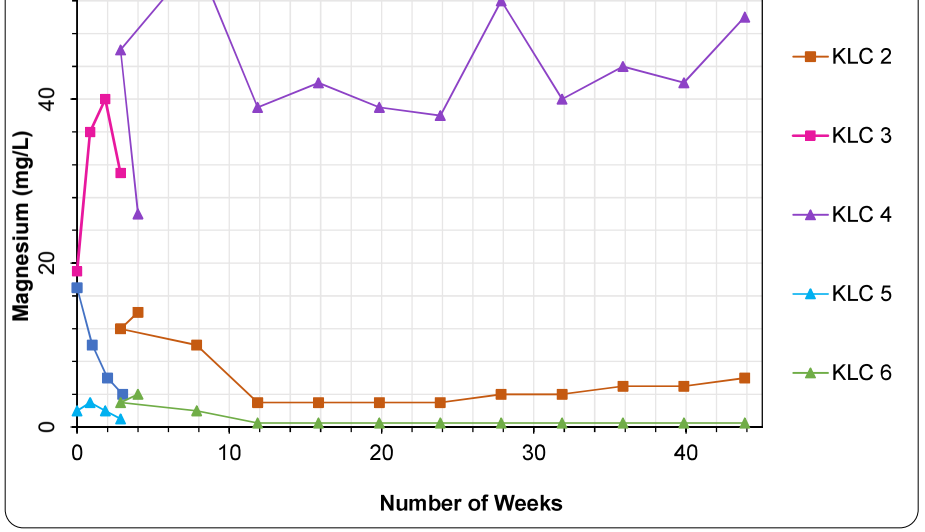

Chloride (mg/L)
0
100
200
300
400
0
10
20
30
Number of Weeks

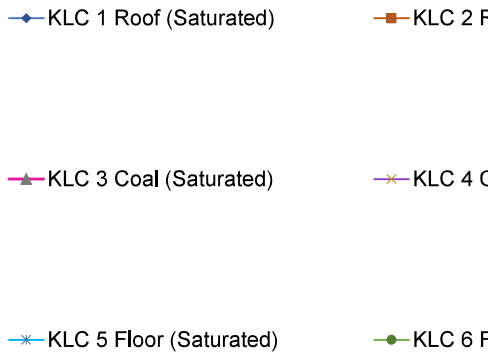

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

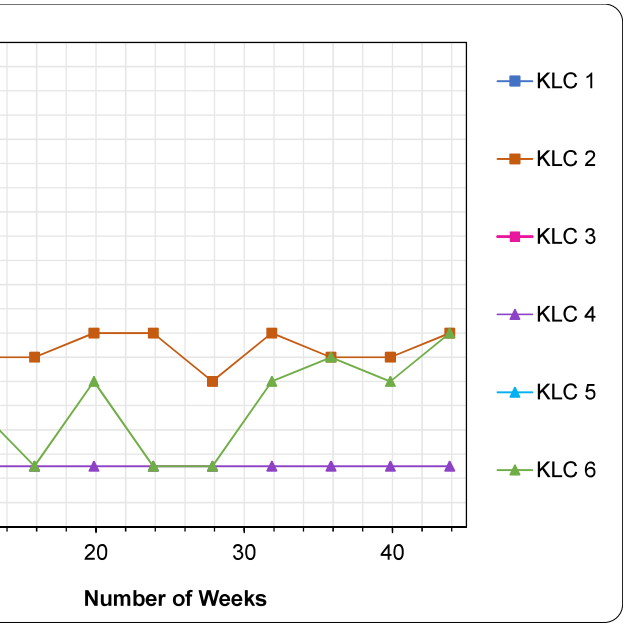

Sodium (mg/L)
0
200
300
400
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

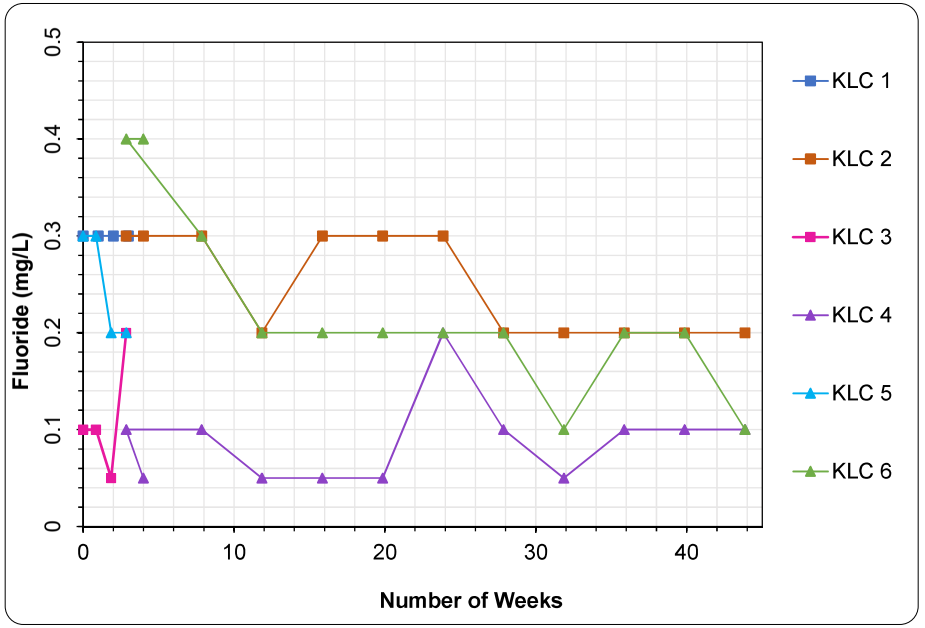

Calcium (mg/L)
50
100
150

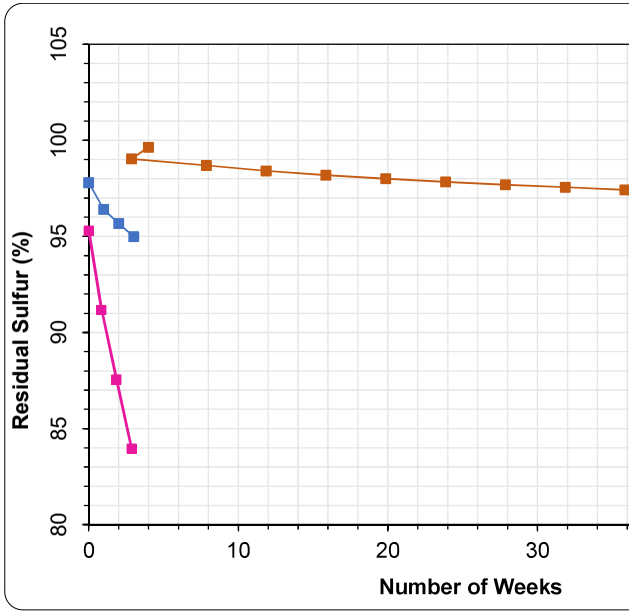

KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

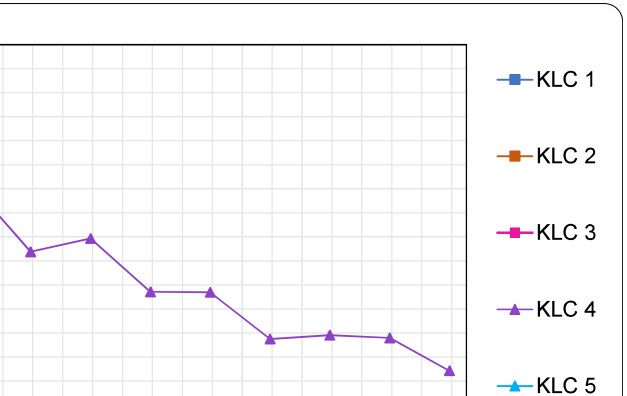

Magnesium (mg/L)
0
20
40
0
10
20
30
40
Number of Weeks
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

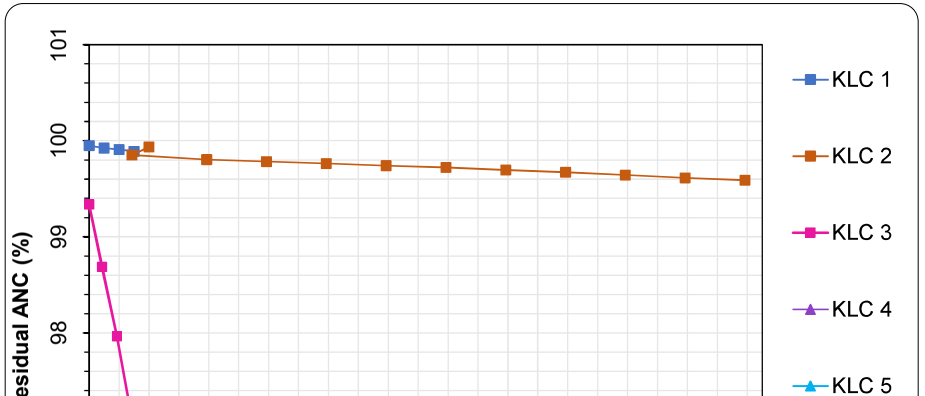

KLC 1 Roof (Saturated)
KLC 2 F
KLC 3 Coal (Saturated)
KLC 4 C
KLC 5 Floor (Saturated)
KLC 6 F

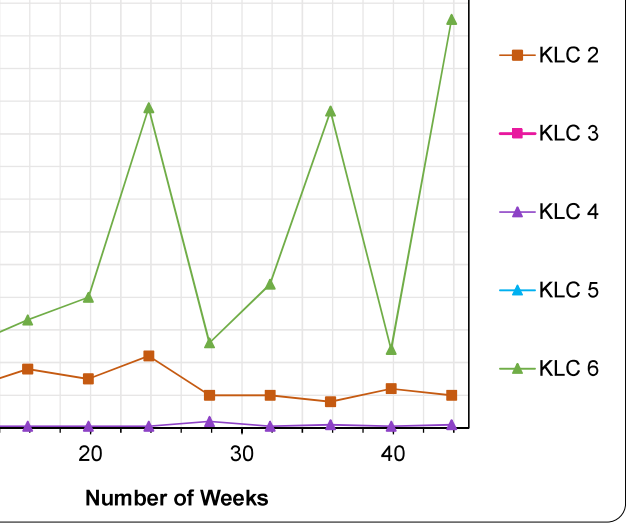

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

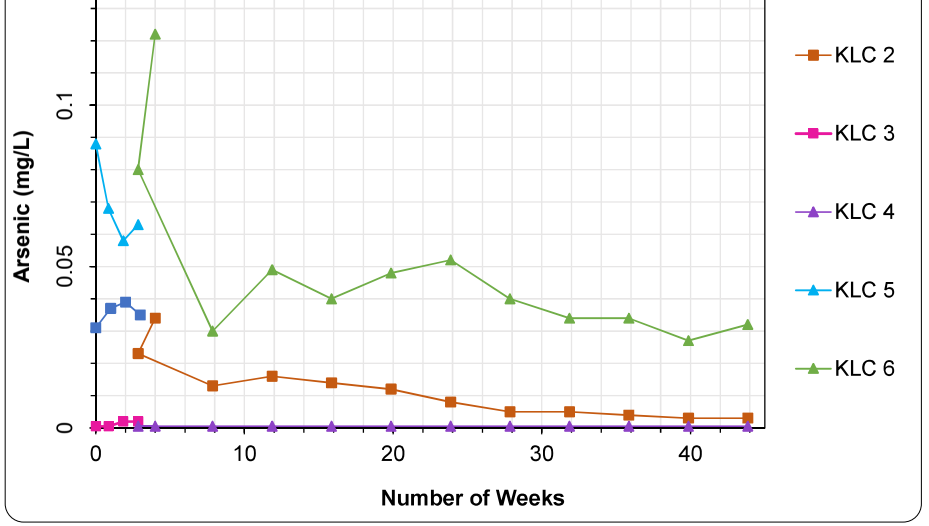

Fluoride (mg/L)
0
0.1
0.2
0.3
0.4
0.5
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

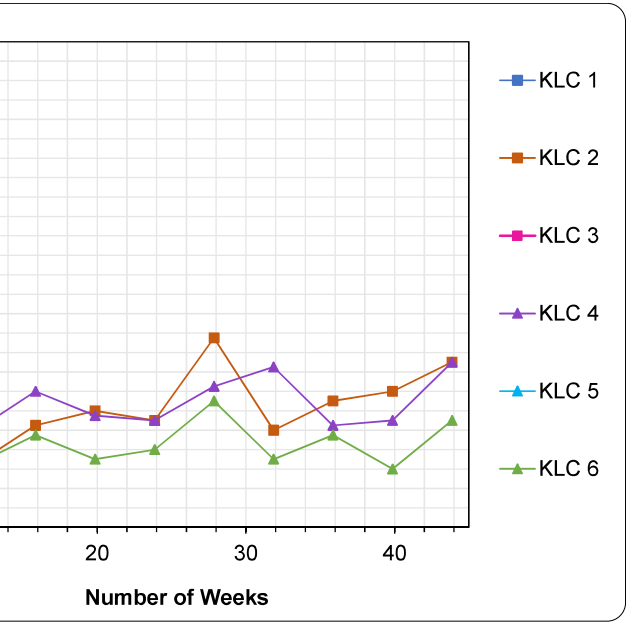

Residual Sulfur (%)
80
85
90
95
100
105
0
10
20
30
Number of Weeks

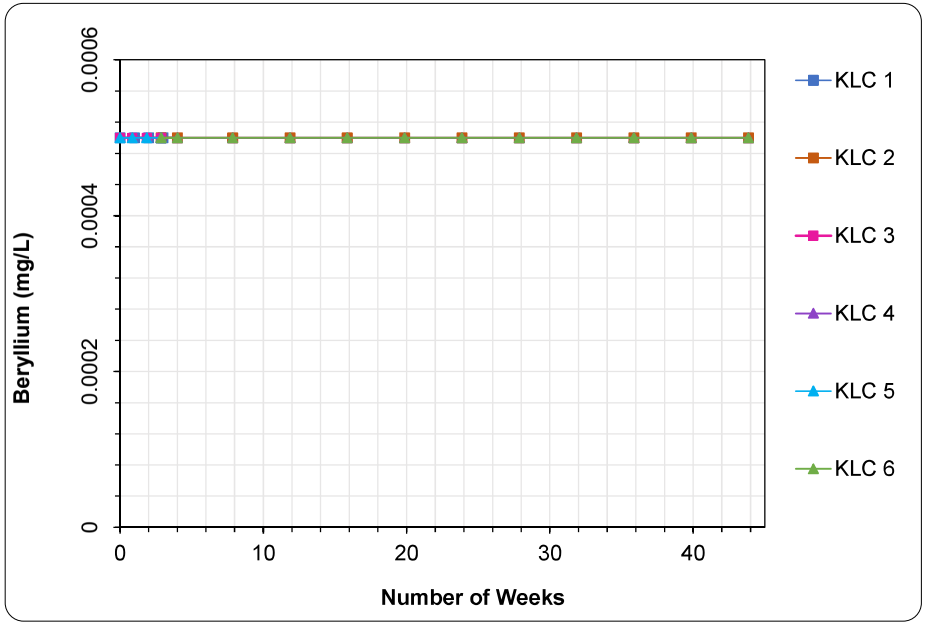

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

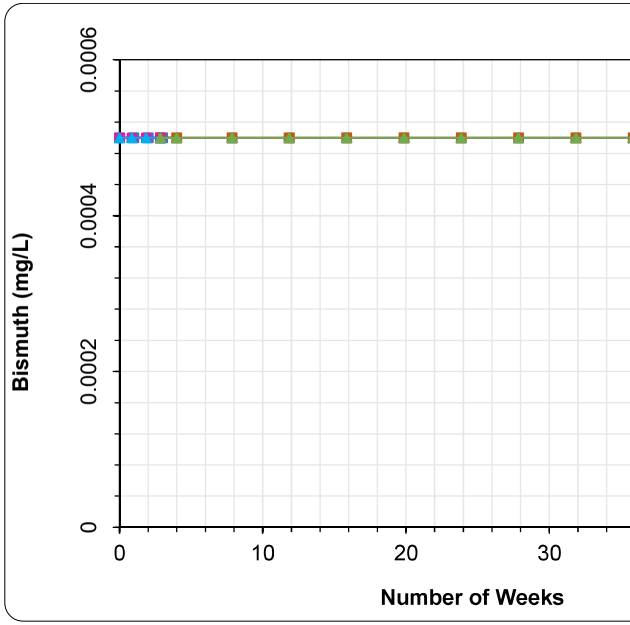

esidual ANC (%)
98
99
100
101
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

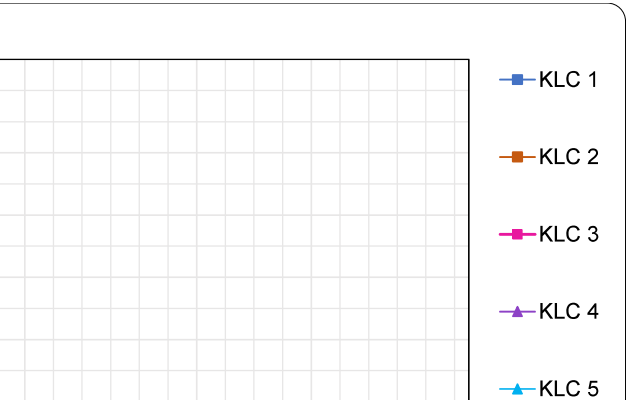

KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

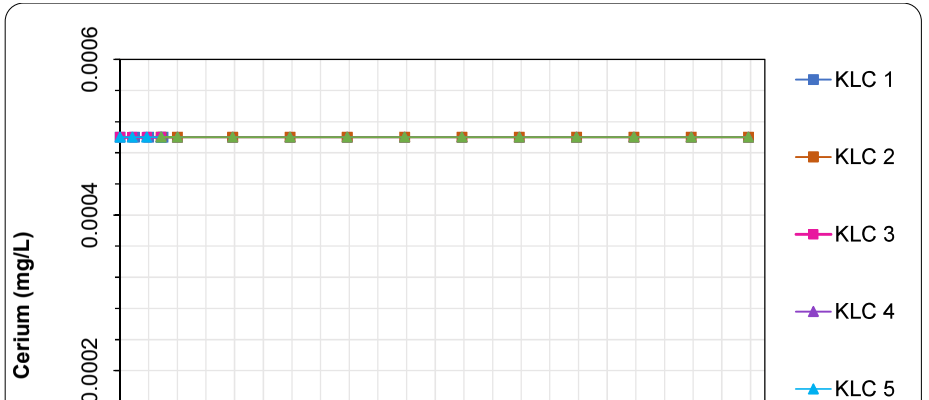

Arsenic (mg/L)
0
0.05
0.1
0
10
20
30
40
Number of Weeks
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6


KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

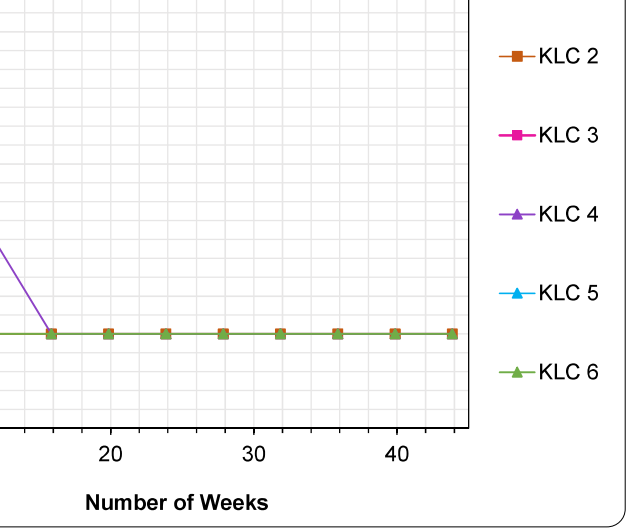

Beryllium (mg/L)
0
0.0002
0.0004
0.0006
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

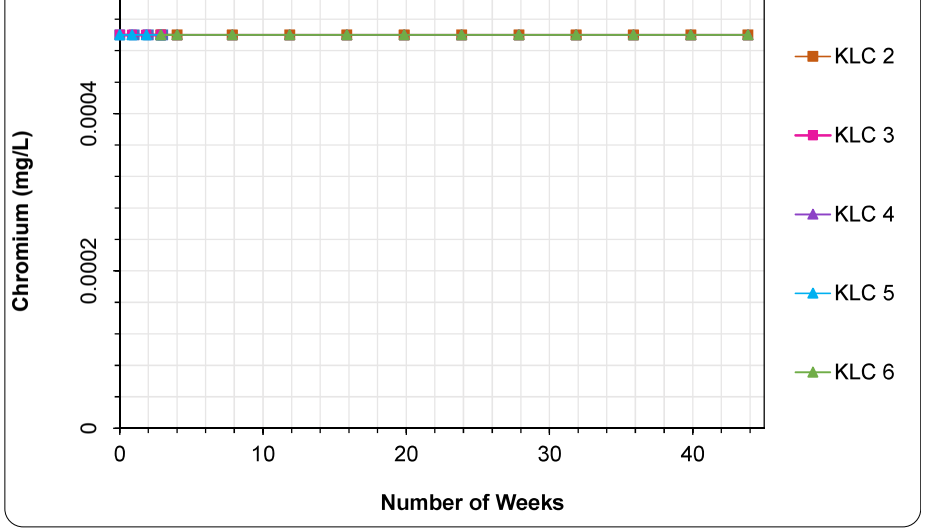

Bismuth (mg/L)
0
0.0002
0.0004
0.0006
0
10
20
30
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

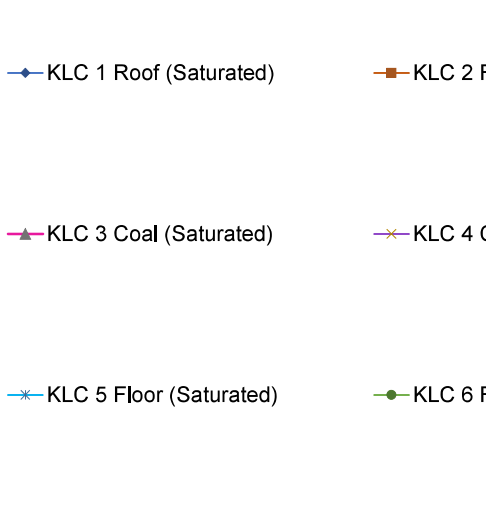

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

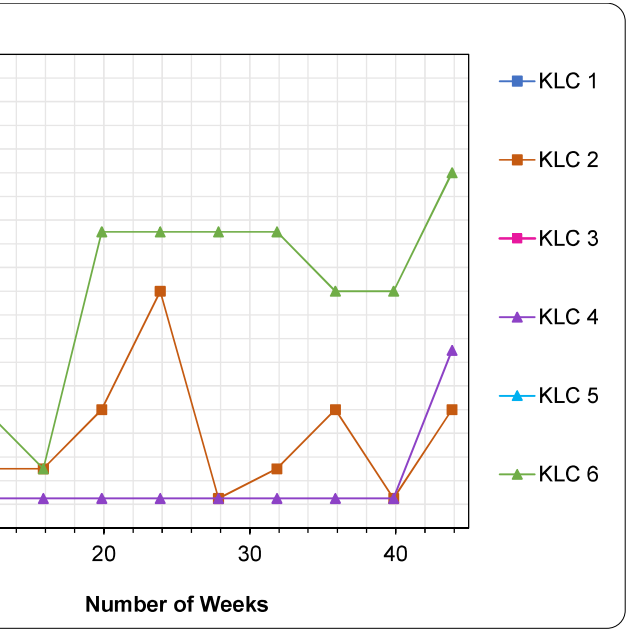

Cerium (mg/L)
0.0002
0.0004
0.0006
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

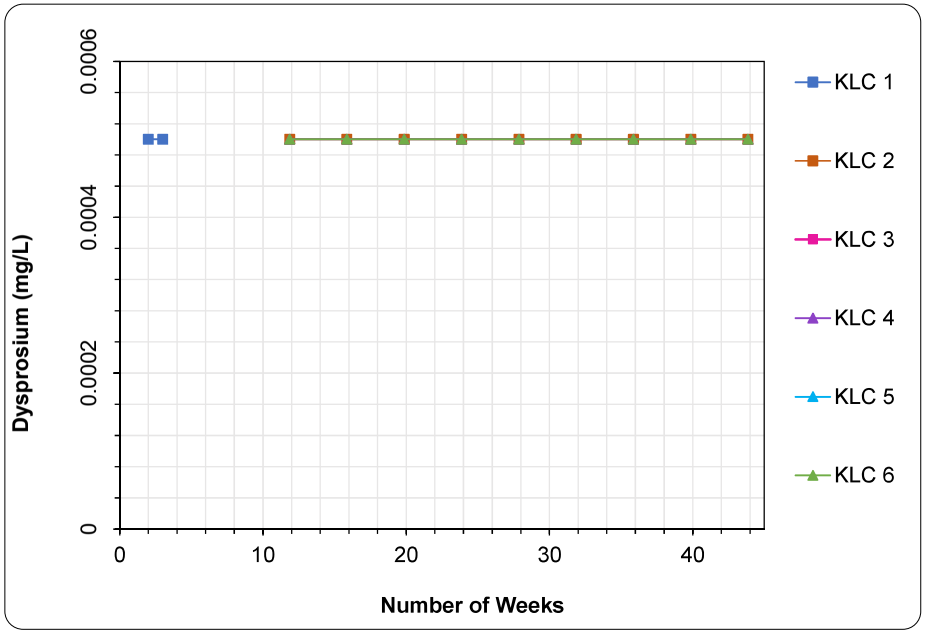

Caesium (mg/L)
0.001
0.0015
0.002
0.0025
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

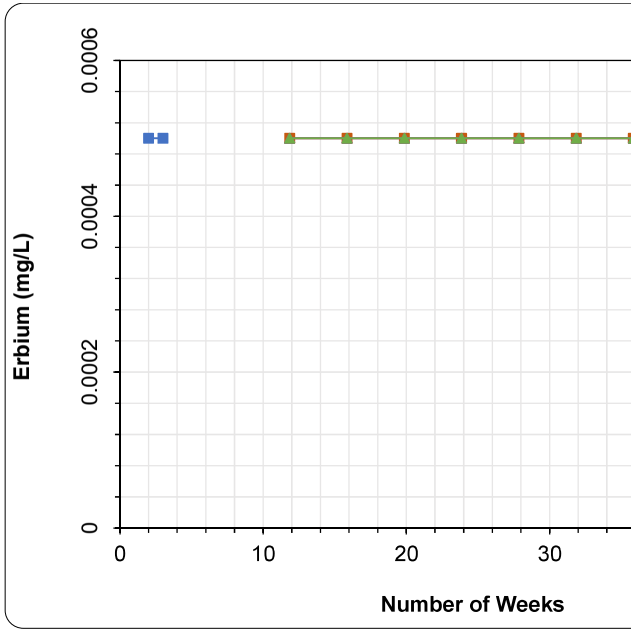

KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

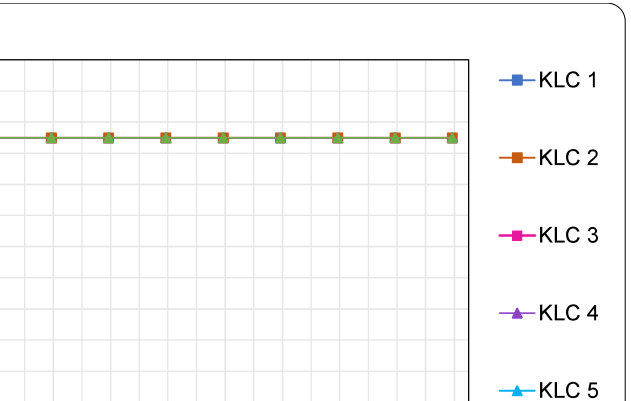

Chromium (mg/L)
0.0004
0.0002
0
0
10
20
30
40
Number of Weeks
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

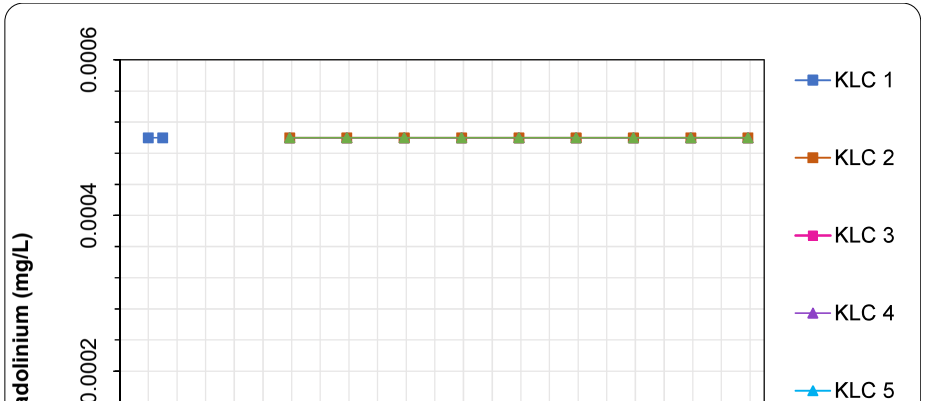

KLC 1 Roof (Saturated)
KLC 2 F
KLC 3 Coal (Saturated)
KLC 4 C
KLC 5 Floor (Saturated)
KLC 6 F

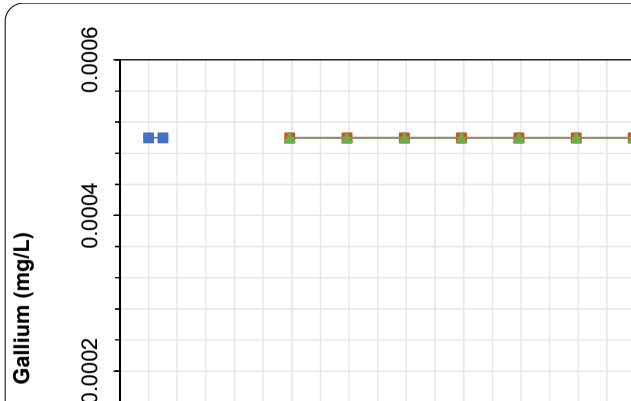

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

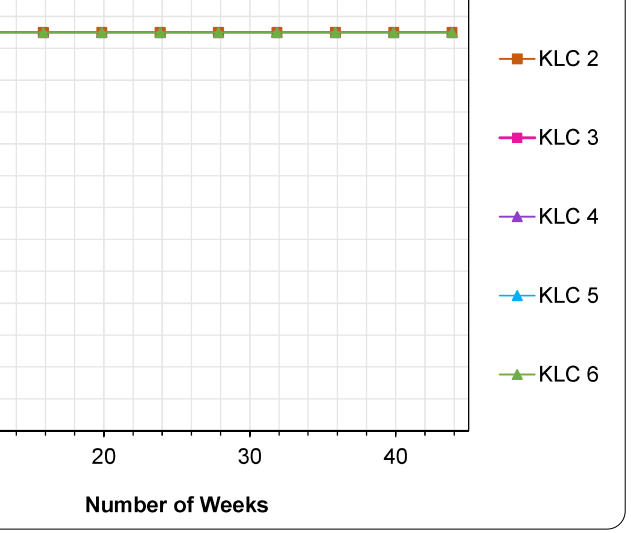

Dysprosium (mg/L)
0.0006
0.0004
0.0002
0
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

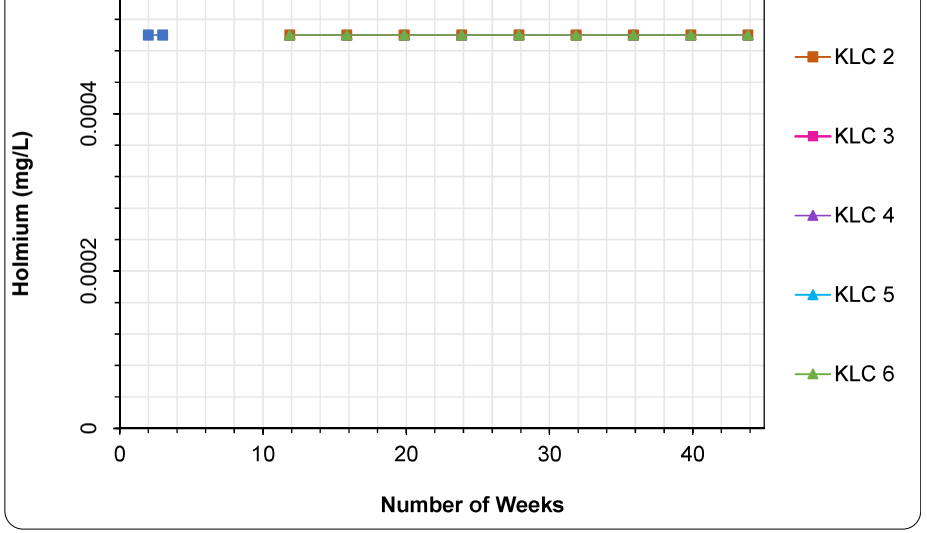

Erbium (mg/L)
0.0006
0.0004
0.0002
0
0
10
20
30
Number of Weeks

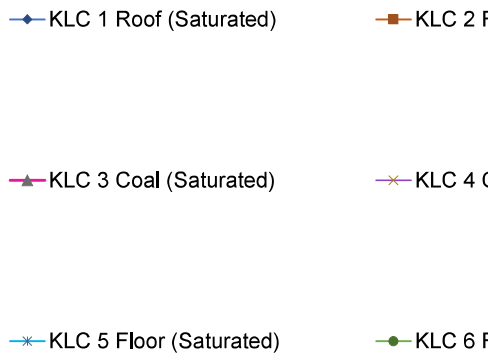

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

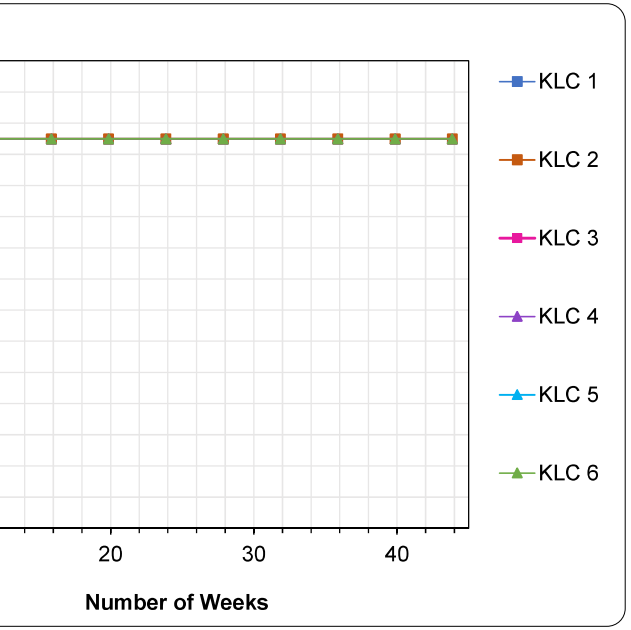

0.0006
0.0004
0.0002
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

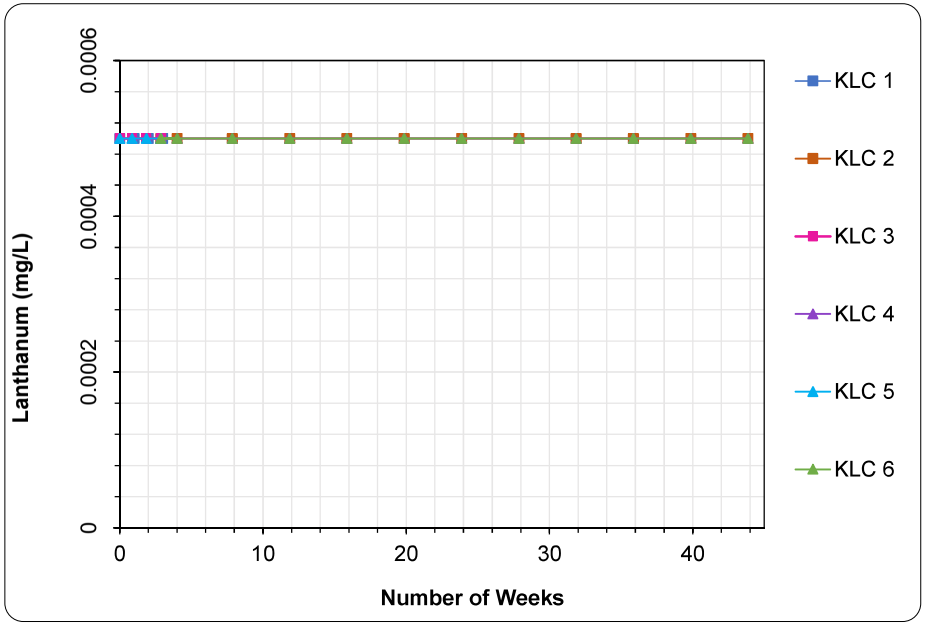

Gallium (mg/L)
0.0006
0.0004
0.0002

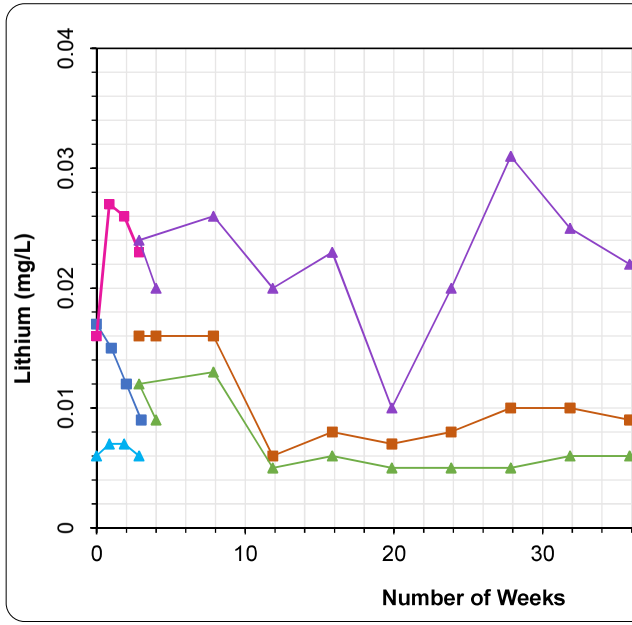

KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

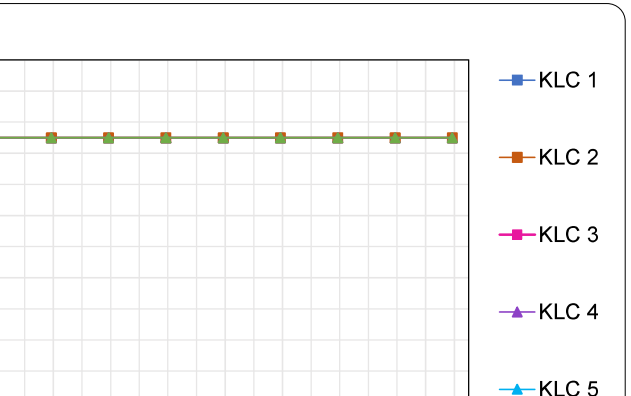

Holmium (mg/L)
0
0.0002
0.0004
0
10
20
30
40
Number of Weeks
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

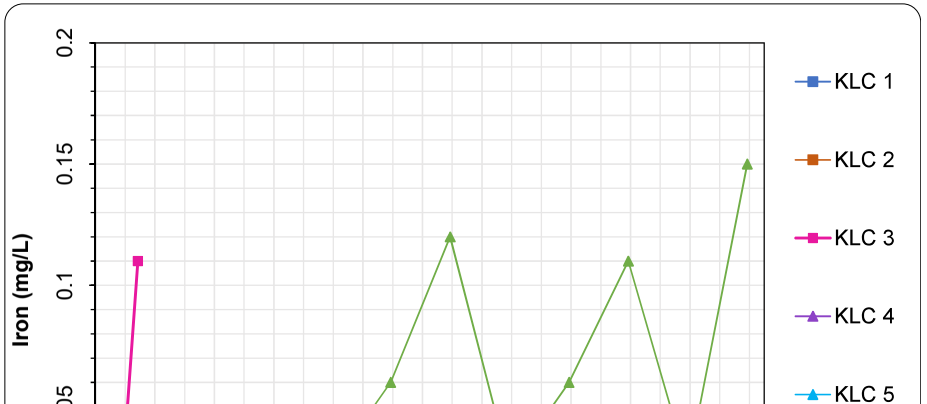

KLC 1 Roof (Saturated)
KLC 2 F
KLC 3 Coal (Saturated)
KLC 4 C
KLC 5 Floor (Saturated)
KLC 6 F

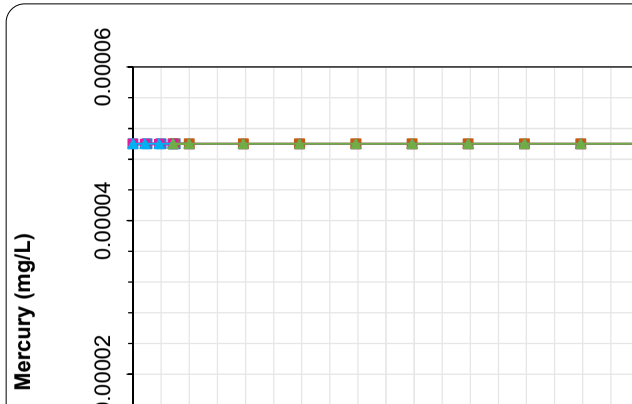

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

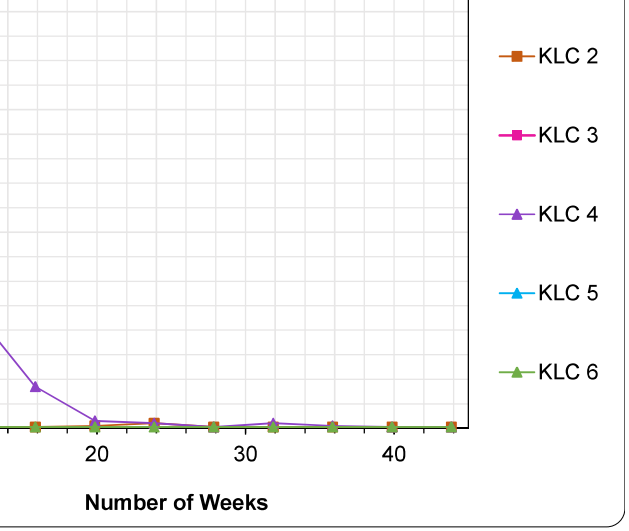

Lanthanum (mg/L)
0
0.0002
0.0004
0.0006
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

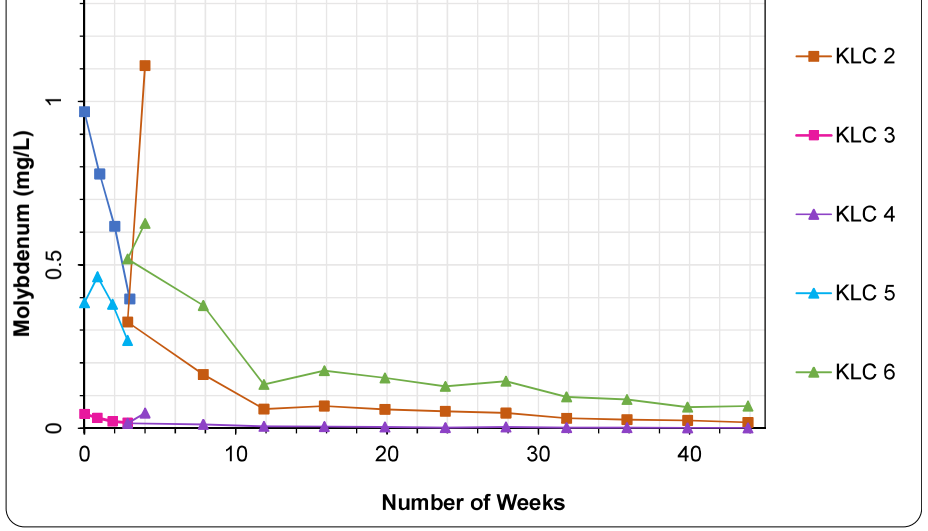

Lithium (mg/L)
0
0.01
0.02
0.03
0.04
0
10
20
30
Number of Weeks

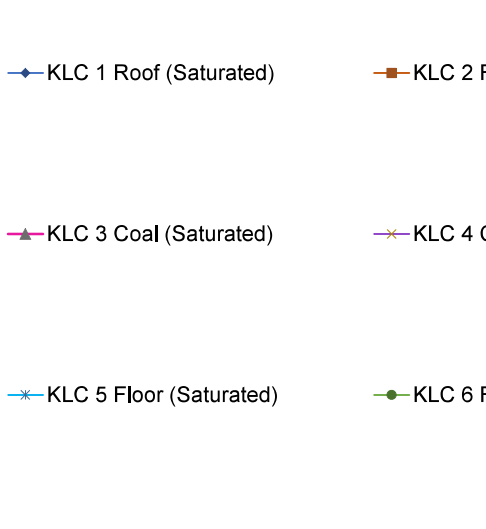

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

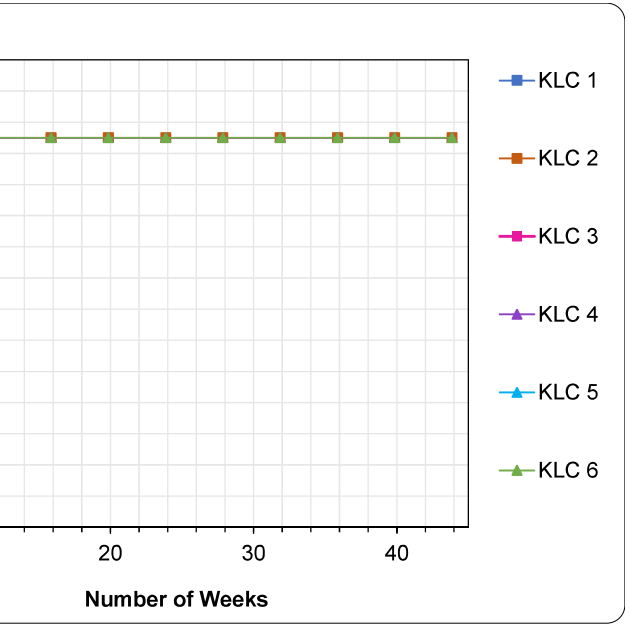

Iron (mg/L)
0.05
0.1
0.15
0.2
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

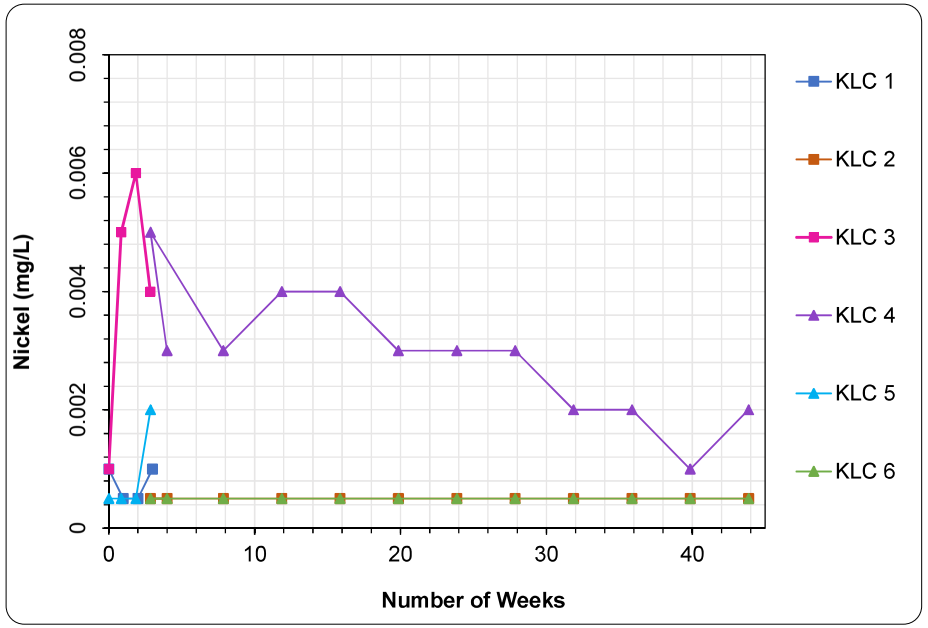

Mercury (mg/L)
0.00002
0.00004
0.00006

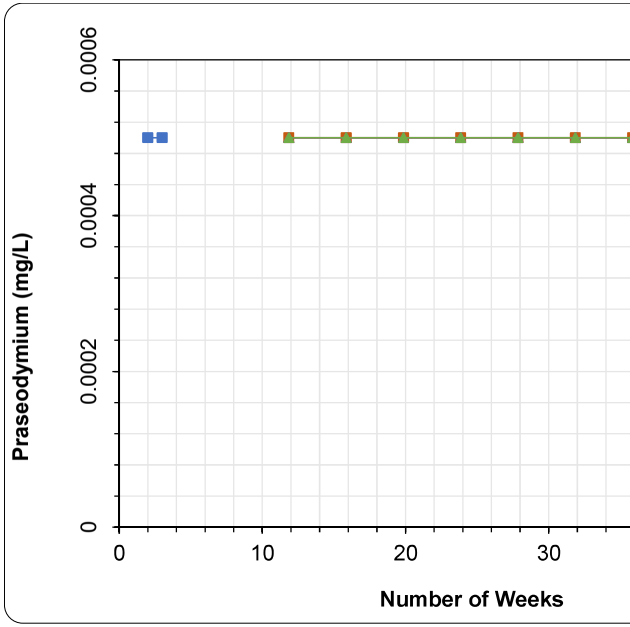

KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

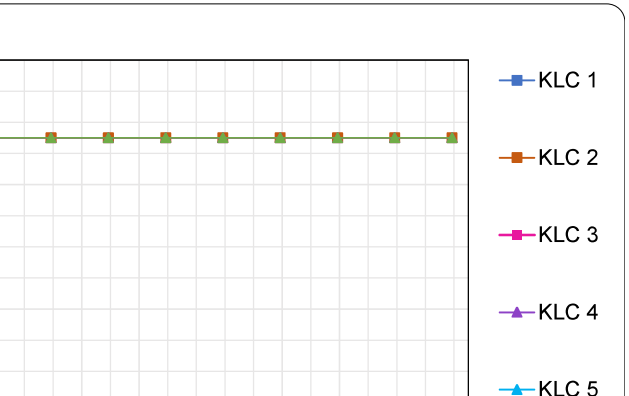

Molybdenum (mg/L)
0
0.5
1
0
10
20
30
40
Number of Weeks
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

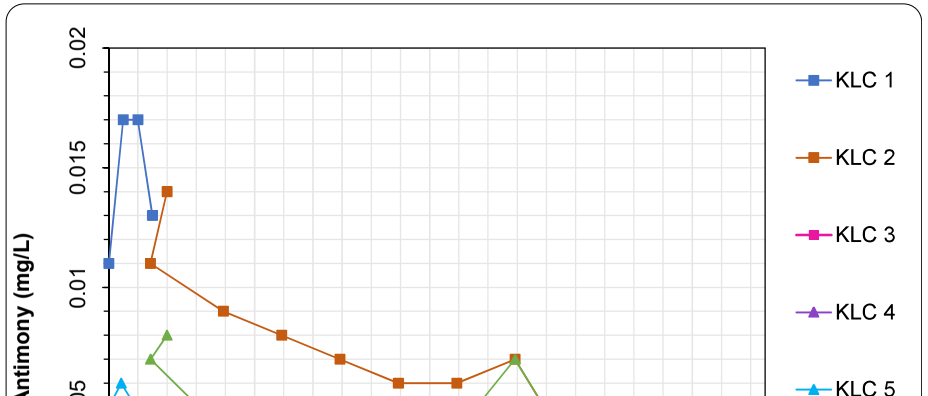

KLC 1 Roof (Saturated)
KLC 2 F
KLC 3 Coal (Saturated)
KLC 4 C
KLC 5 Floor (Saturated)
KLC 6 F

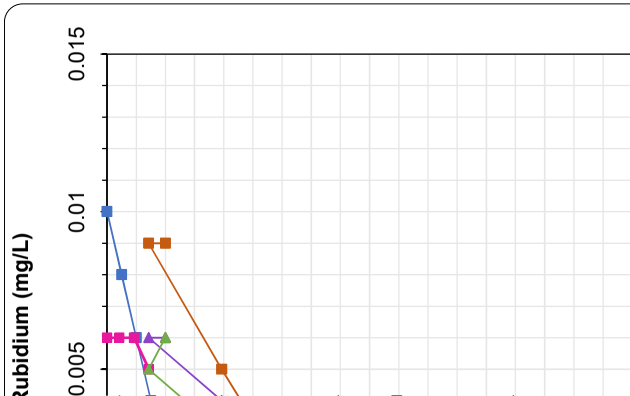

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

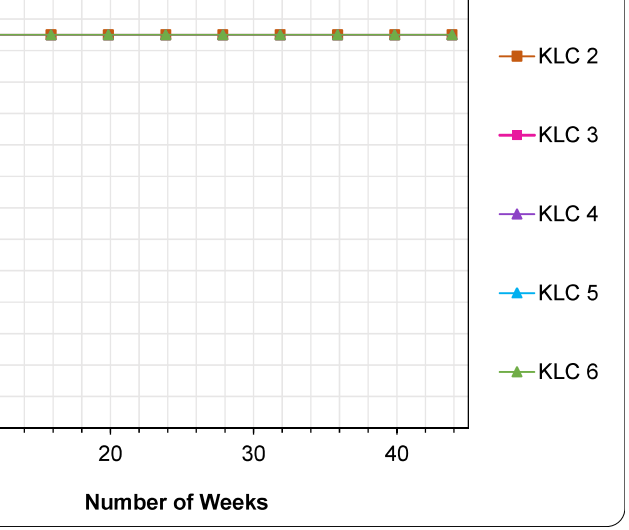

Nickel (mg/L)
0
0.002
0.004
0.006
0.008
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

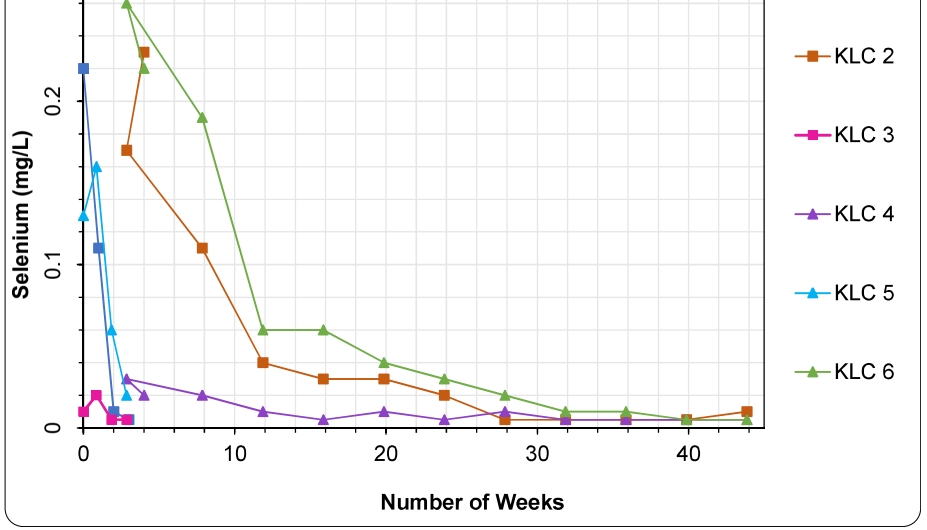

Praseodymium (mg/L)
0
0.0002
0.0004
0.0006
0
10
20
30
Number of Weeks

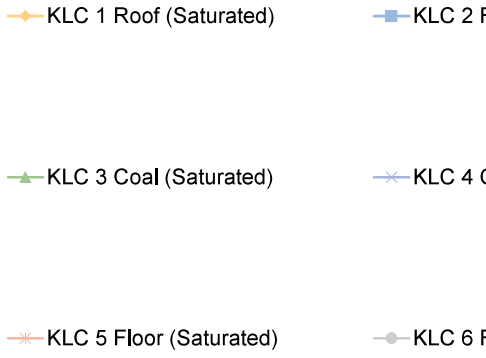

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

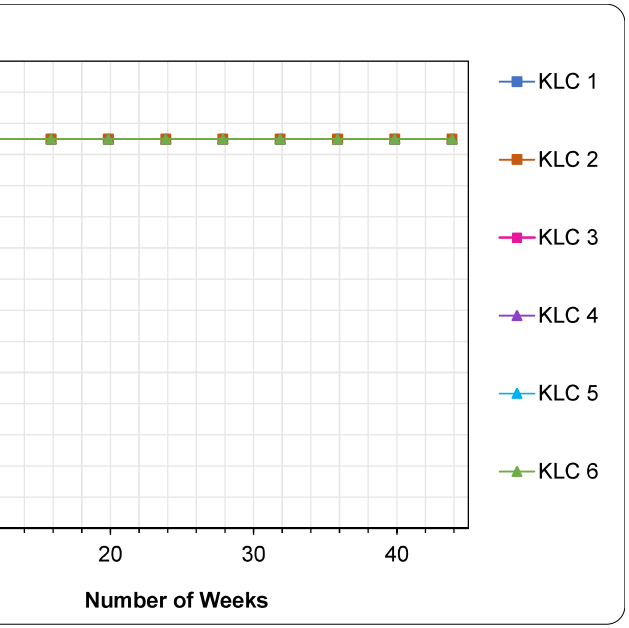

Antimony (mg/L)
0.01
0.015
0.02
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

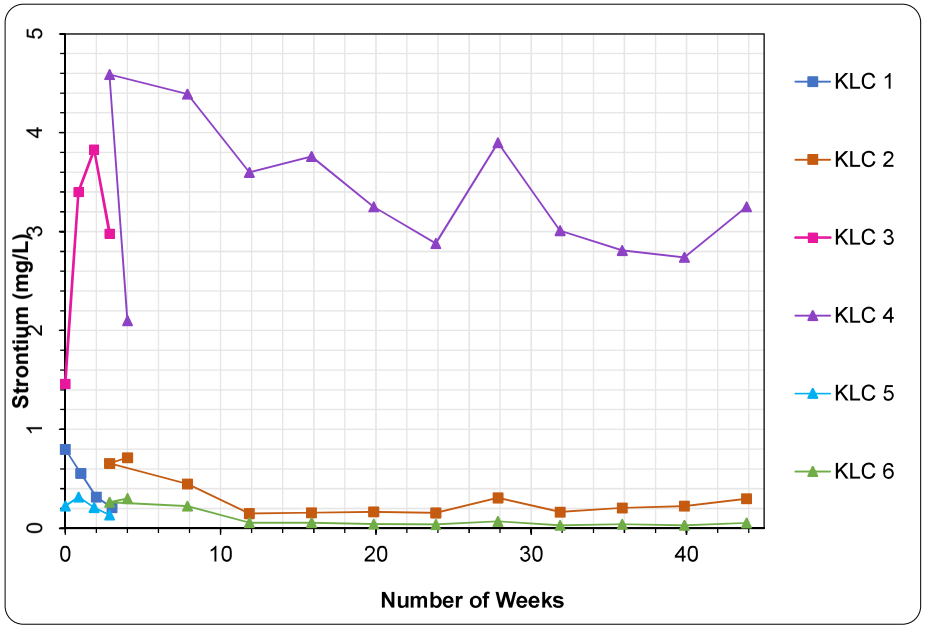

Rubidium (mg/L)
0.005
0.01
0.015

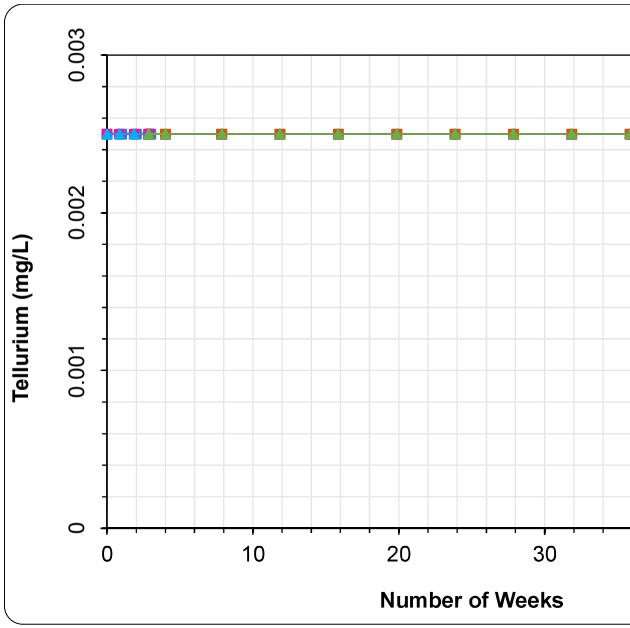

KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

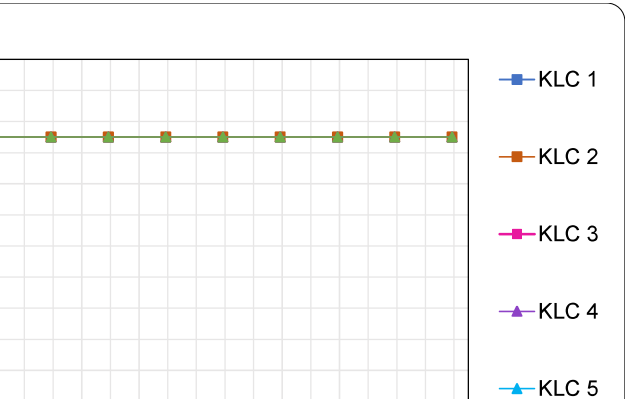

Selenium (mg/L)
0
0.1
0.2
0
10
20
30
40
Number of Weeks
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

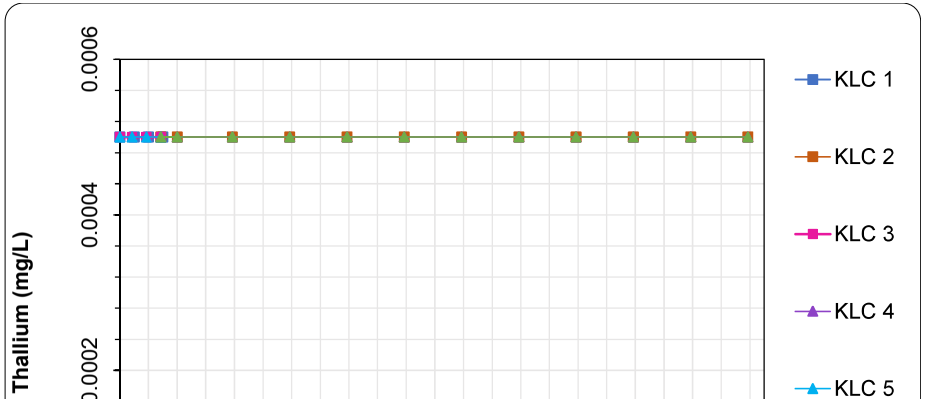

KLC 1 Roof (Saturated)
KLC 2 F
KLC 3 Coal (Saturated)
KLC 4 C
KLC 5 Floor (Saturated)
KLC 6 F

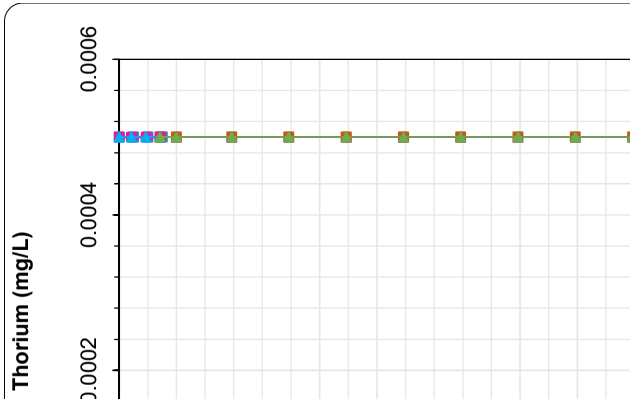

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

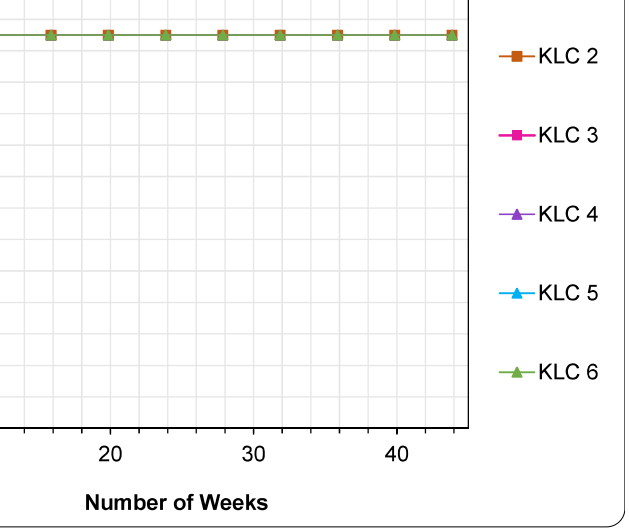

Strontium (mg/L)
0
1
2
3
4
5
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

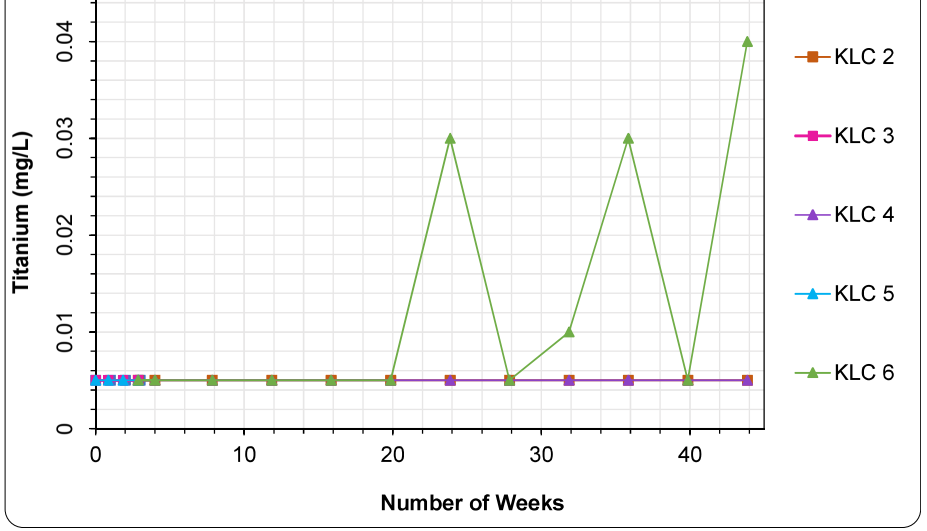

Tellurium (mg/L)
0
0.001
0.002
0.003
0
10
20
30
Number of Weeks

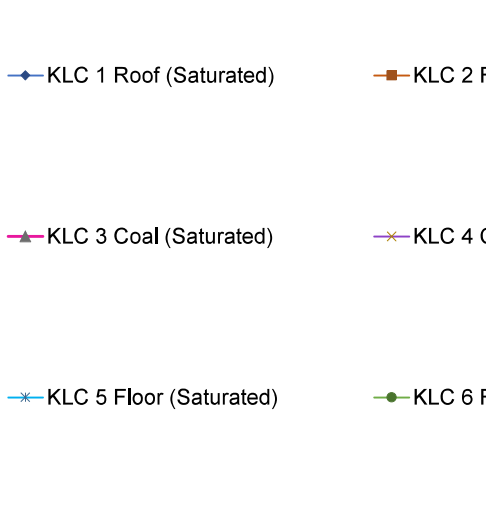

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

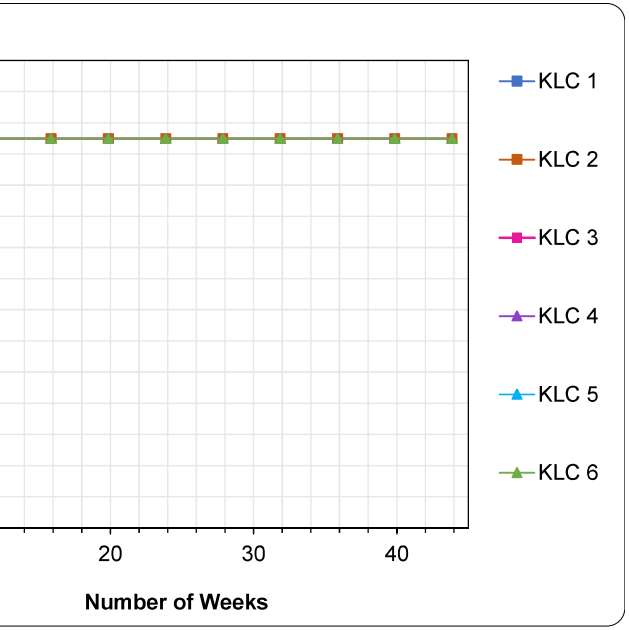

Thallium (mg/L)
0.0002
0.0004
0.0006
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

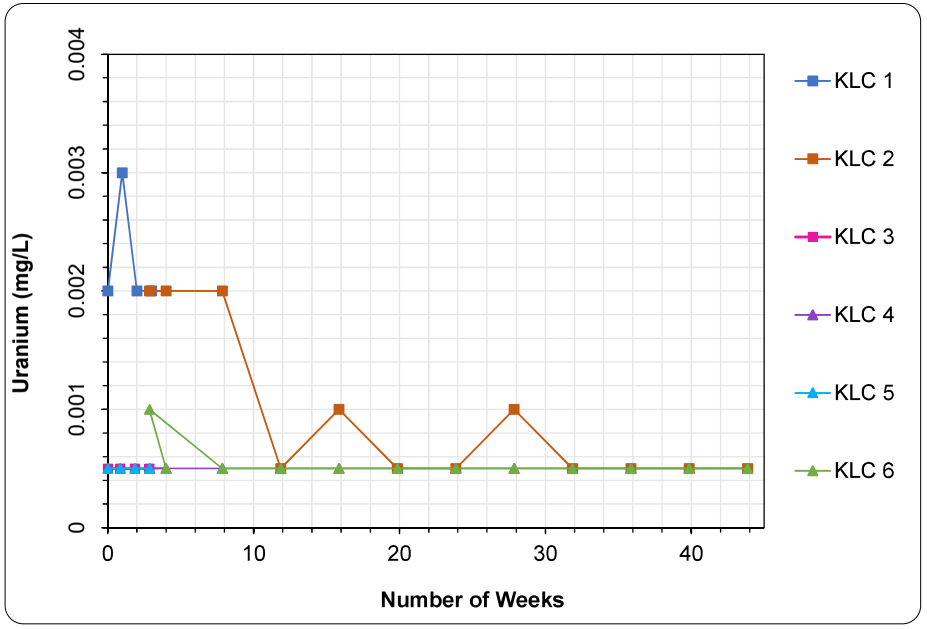

Thorium (mg/L)
0.0002
0.0004
0.0006

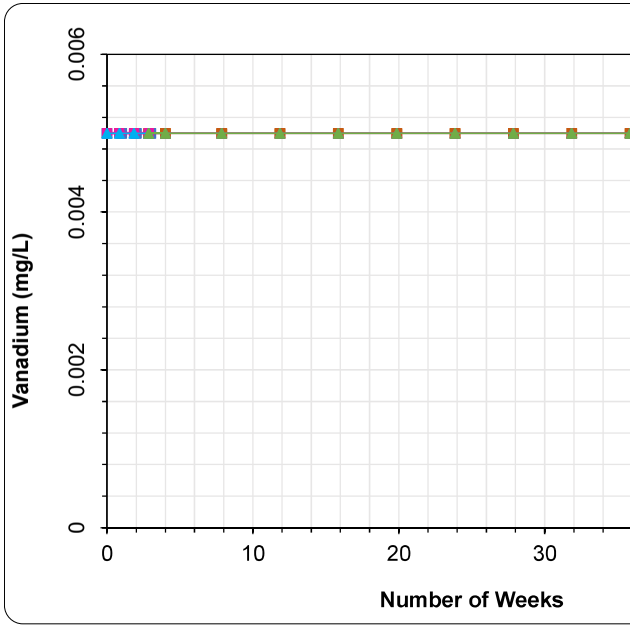

KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

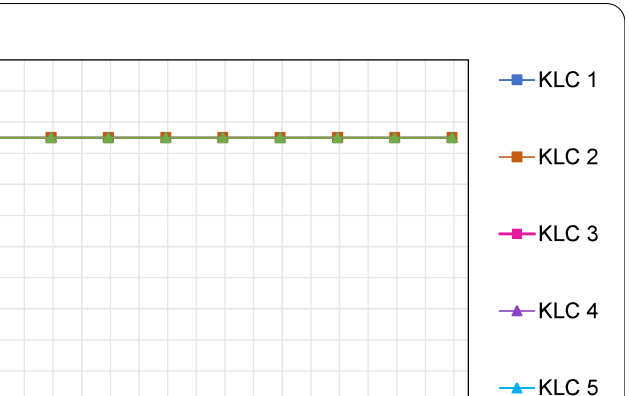

Titanium (mg/L)
0
0.01
0.02
0.03
0.04
0
10
20
30
40
Number of Weeks
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

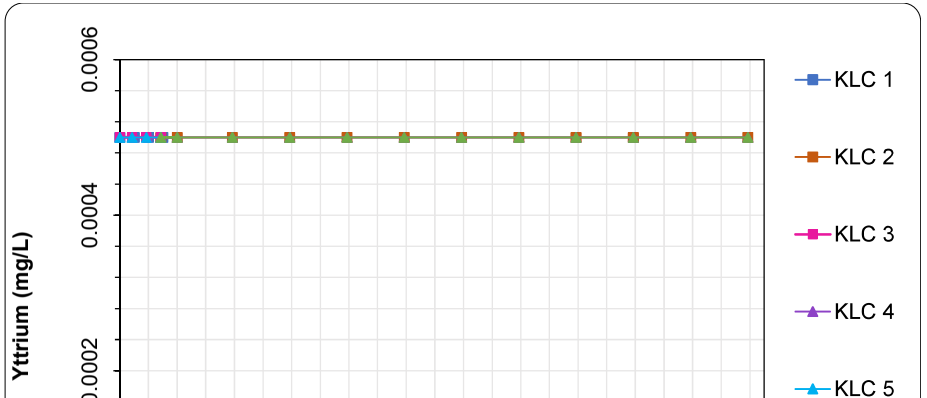

KLC 1 Roof (Saturated)
KLC 2 F
KLC 3 Coal (Saturated)
KLC 4 C
KLC 5 Floor (Saturated)
KLC 6 F

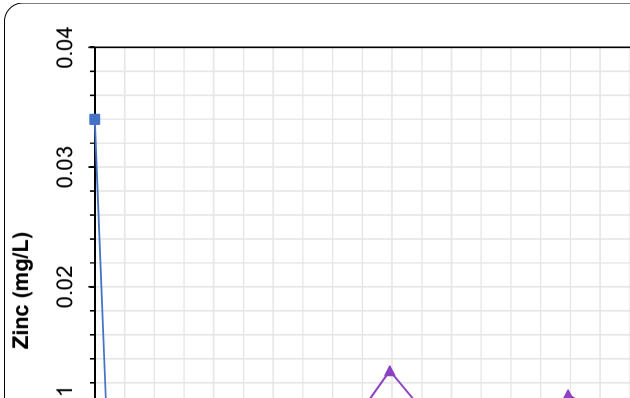

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

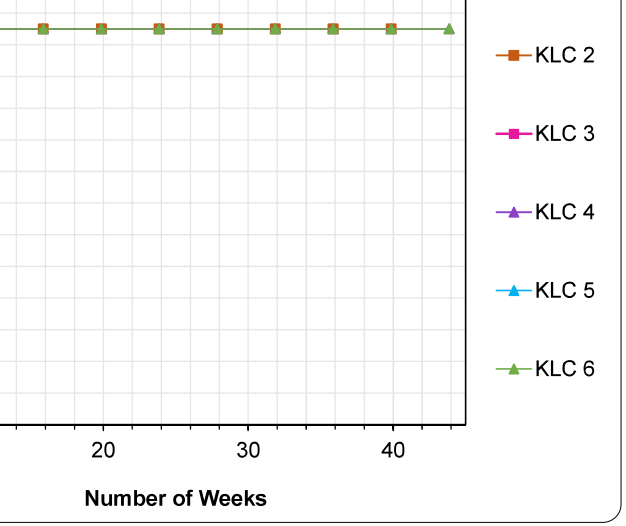

Uranium (mg/L)
0
0.001
0.002
0.003
0.004
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6

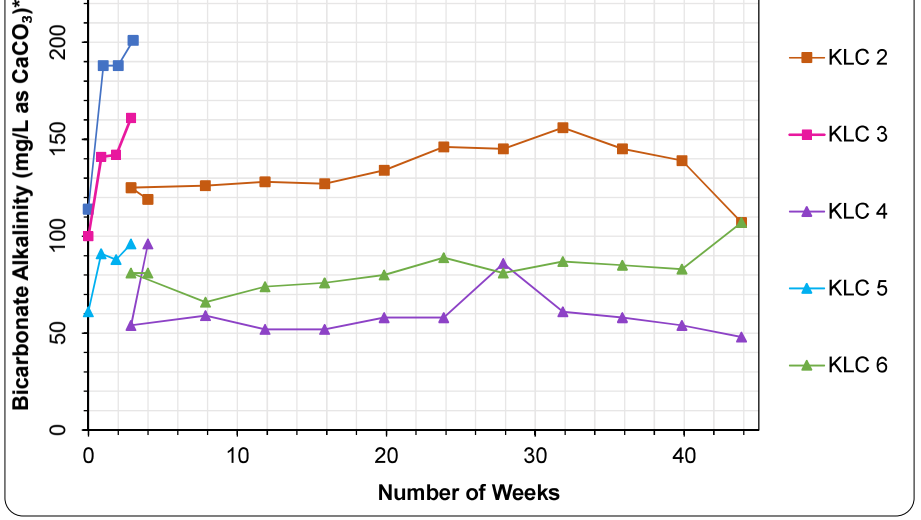

Vanadium (mg/L)
0
0.002
0.004
0.006
0
10
20
30
Number of Weeks

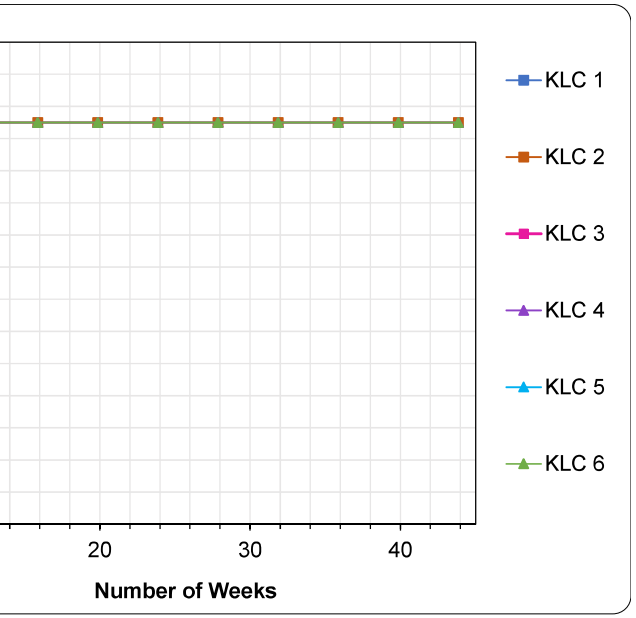

KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

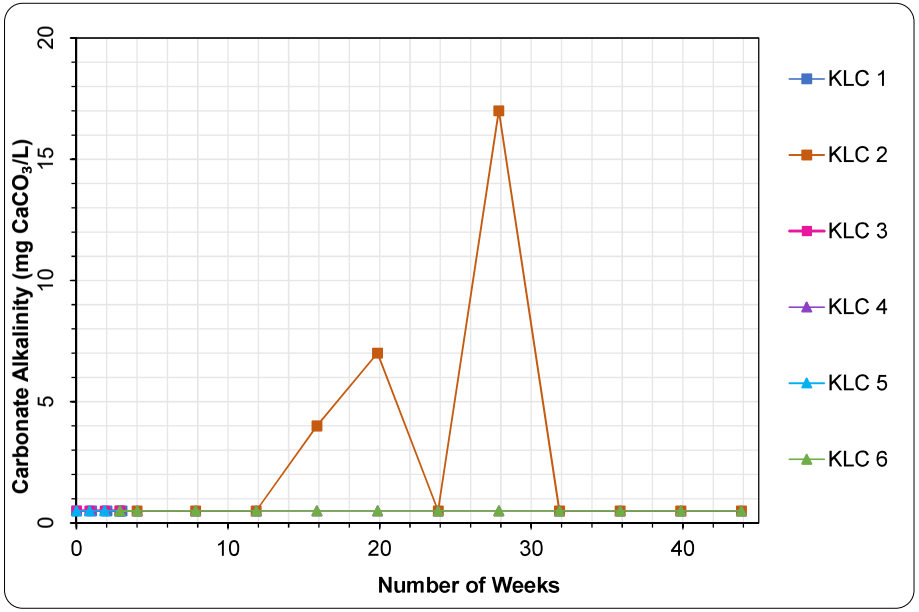

Yttrium (mg/L)
0.0002
0.0004
0.0006
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5

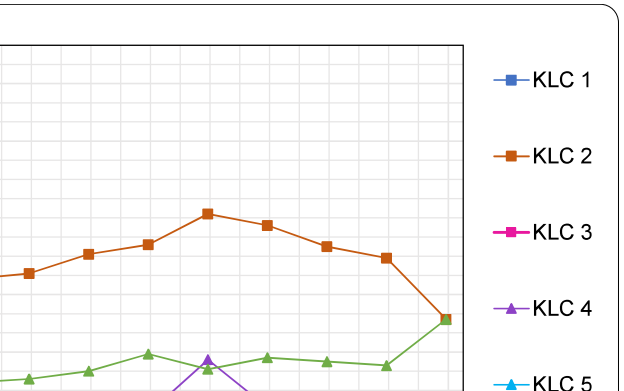

Zinc (mg/L)
0.02
0.03
0.04

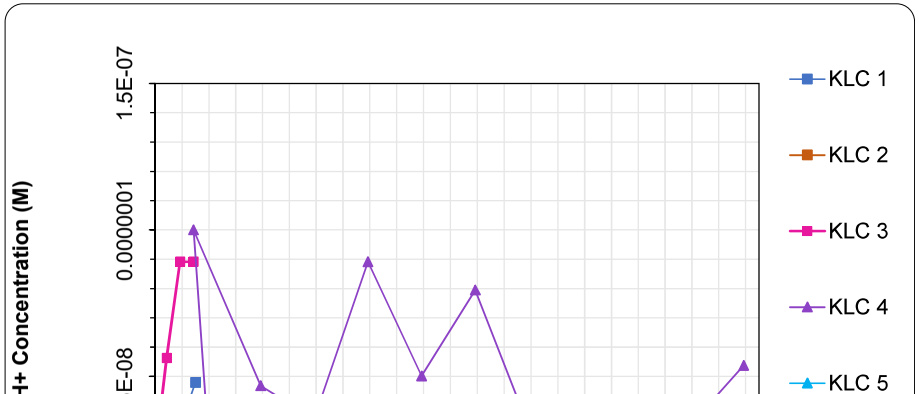

KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks

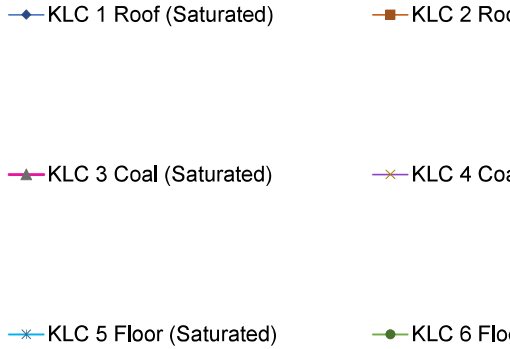

Bicarbonate Alkalinity (mg/L as CaCO3)*
0
50
100
150
200
0
10
20
30
40
Number of Weeks
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6


KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6
20
30
40
Number of Weeks


Carbonate Alkalinity (mg CaCO3/L)
0
5
10
15
20
0
10
20
30
40
Number of Weeks
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5
KLC 6


KLC 1
KLC 2
KLC 3
KLC 4
KLC 5


1.5E-07
0.0000001
E-08
KLC 1
KLC 2
KLC 3
KLC 4
KLC 5


KLC 1 Roof (Saturated)
KLC 2 Roo
KLC 3 Coal (Saturated)
KLC 4 Coa
KLC 5 Floor (Saturated)
KLC 6 Flo

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	
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	
ised 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	
Measurement) (µS/cm)			1,807	1,291	932	736	1,844	1,537	1,490	632	499	542	450	519	394	342	
Measurement) (µS/cm)	-	-	1850	1360	918	664	1880	1640	1260	817	709	602	612	586	510	502	
cidity (mg/L as $CaCO_3$)*	-	-	1.0	2.0	2.0	<1	<1	<1	1.0	<1	<1	<1	<1	<1	<1	4	
linity (mg/L as $CaCO_3$)*	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
linity (mg/L as $CaCO_3$)*	-	-	<1	<1	<1	<1	<1	<1	<1	<1	4.0	7.0	<1	17.0	<1	<1	
linity (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	
linity (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	

Elements	LoR	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]														
Ca	1	-	1000	20	11	6	6	18	14	11	4	4	4	4	6	4	5
K	1	-	-	9	7	6	6	9	8	9	4	4	11	4	4	4	5
Mg	1	-	-	17	10	6	4	14	12	10	3	3	3	3	4	4	5
Na	1	-	-	344	268	202	157	358	308	260	106	106	100	85	112	79	80
Cl	1	-	-	308	165	82	41	317	214	109	44	21	10	7	4	3	3
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
SO_4	1	-	1000	405	286	153	84	400	426	356	208	163	137	139	114	107	109

Elements	LoR	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]														
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
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
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
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
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
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
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
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
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
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
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
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
Dy	0.001	-	-	---	---	<0.001	<0.001	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Er	0.001	-	-	---	---	<0.001	<0.001	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Eu	0.001	-	-	---	---	<0.001	<0.001	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Gd	0.001	-	-	---	---	<0.001	<0.001	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ga	0.001	-	-	---	---	<0.001	<0.001	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hf	0.01	-	-	---	---	<0.01	<0.01	---	---	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ho	0.001	-	-	---	---	<0.001	<0.001	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
Lu	0.001	-	-	---	---	<0.001	<0.001	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
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
Nd	0.001	-	-	---	---	<0.001	<0.001	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
Pr	0.001	-	-	---	---	<0.001	<0.001		---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
Sm	0.001	-	-	---	---	<0.001	<0.001	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
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
Tb	0.001	-	-	---	---	<0.001	<0.001	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
Tm	0.001	-	-	---	---	<0.001	<0.001	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
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
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
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
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
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

meq/L	-		19.4	---	9.25	6.92	19.6	17.4	13	---	---	---	---	5.72	5.43	5.25	
meq/L	-		17.6	---	9.73	7.61	17.8	15.3	12.9	---	---	---	---	5.6	4.07	4.27	
%	-		4.89	---	2.52	4.74	4.79	6.47	0.36	---	---	---	---	1.06	---	10.3	

Elements																
SO_4		142	89	47	44	87	146	81	69	53	44	42	34	32	31	
Cum SO_4		142	231	279	323	87	233	314	383	436	480	521	555	587	618	
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	

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	
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	
ised 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	
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	
Measurement) (µS/cm)	-	-	1350	1910	1730	1280	1480	2110	1790	1840	1550	1,530	1,300	1,260	1090	1,170	
cidity (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	
linity (mg/L as $CaCO_3$)*	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
linity (mg/L as $CaCO_3$)*	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
linity (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	
linity (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	
Elements	LoR	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]														
Ca	1	-	1000	48	84	94	75	64	118	135	111	118	97	98	137	116	121
K	1	-	-	5	7	6	6	5	7	6	4	4	4	4	4	3	3
Mg	1	-	-	19	36	40	31	26	46	57	39	42	39	38	52	40	44
Na	1	-	-	201	228	247	187	220	272	216	116	99	66	43	52	24	20
Cl	1	-	-	83	108	94	62	94	92	48	45	27	14	7	4	2	3
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
SO_4	1	-	1000	476	772	675	444	549	969	861	924	746	799	670	615	565	622
Elements	LoR	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]														
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
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
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
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
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
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
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
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
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
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
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
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
Dy	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Er	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Eu	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Gd	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ga	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hf	0.01	-	-	---	---	---	---	---	---	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ho	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
Lu	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
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
Nd	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
Pr	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
Sm	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
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
Tb	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
Tm	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
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
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
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
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
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
meq/L	-			14.2	---	19.5	14.2	16	23.8	20.4	---	---	---	---	14.6	13	14.2
meq/L	-			12.8	---	18.9	14.6	15	21.7	21	---	---	---	---	13.5	10.2	10.6
%	-			5.24	---	1.72	1.29	3.12	4.75	1.25	---	---	---	---	4.11	---	14.5
Elements																	
SO_4				180	159	139	137	140	323	209	284	228	239	194	194	155	158
Cum SO_4				180	339	477	615	140	463	673	957	1184	1423	1617	1811	1966	2124
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

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
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
ised 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
Measurement) (µS/cm)			748	857	734	562	1,138	1,128	1,040	481	389	308	268	303	237	213
Measurement) (µS/cm)	-	-	760	891	720	531	1150	1080	967	618	537	414	391	363	308	310
cidity (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
linity (mg/L as $CaCO_3$)*	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
linity (mg/L as $CaCO_3$)*	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
linity (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
linity (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

Elements	LoR	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]													
Ca	1	-	1000	4	6	5	3	11	7	4	1	1	<1	<1	1	<1	<1
K	1	-	-	4	5	4	3	5	5	5	7	2	4	2	2	2	3
Mg	1	-	-	2	3	2	1	4	3	2	<1	<1	<1	<1	<1	<1	<1
Na	1	-	-	146	176	144	114	221	234	188	80	79	66	55	69	51	58
Cl	1	-	-	142	158	109	63	228	180	106	43	22	11	6	3	2	1
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
SO_4	1	-	1000	101	123	102	70	162	192	205	126	114	95	86	71	66	66

Elements	LoR	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]													
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
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
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
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
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
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
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
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
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
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
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
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
Dy	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Er	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Eu	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Gd	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ga	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hf	0.01	-	-	---	---	---	---	---	---	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ho	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
Lu	0.001	-	-			---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
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
Nd	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
Pr	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
Sm	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
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
Tb	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
Tm	0.001	-	-	---	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
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
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
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
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
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
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
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
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

meq/L	-	7.33	---	6.96	5.15	11.4	10.7	8.58	---	---	---	---	3.18	3.17	3.1
meq/L	-	6.82	---	6.78	5.27	10.6	10.9	8.67	---	---	---	---	3.1	2.27	2.6
%	-	3.61	---	1.29	1.1	3.65	0.97	0.54	---	---	---	---	1.26	---	8.79

Elements															
SO_4	34	36	29	31	30	66	42	35	35	30	26	20	19	18
Cum SO_4	34	70	99	130	30	97	138	173	208	238	264	284	303	321
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

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)

ALS Environmental

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**	----	----	----	----	

ALS Environmental

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)				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	----	----
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**	----	----

ALS Environmental

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		

ilac-MRA 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*
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)			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	----	----
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		

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-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)			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								
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**	----	----

ALS Environmental

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**	----	----

ALS Environmental

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		

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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
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**	**----**	**----**

ALS Environmental

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**	**----**	**----**

ALS Environmental

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		

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		

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**	----	----

ALS Environmental

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		

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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**	----	----	----

ALS Environmental

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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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)

ALS Environmental

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		

ilac-MRA 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*
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)			Sample ID	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
Compound	CAS Number	LOR	Unit	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)			Sample ID	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
Compound	CAS Number	LOR	Unit	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)			Sample ID	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
Compound	CAS Number	LOR	Unit	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)

ALS Environmental

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)

ALS Environmental

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.

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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)			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
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		

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)			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
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)

ALS Environmental

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		

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)				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
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)			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
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)				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
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

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Soil Rock Calibration

Brisbane
346A Bilsen Road,
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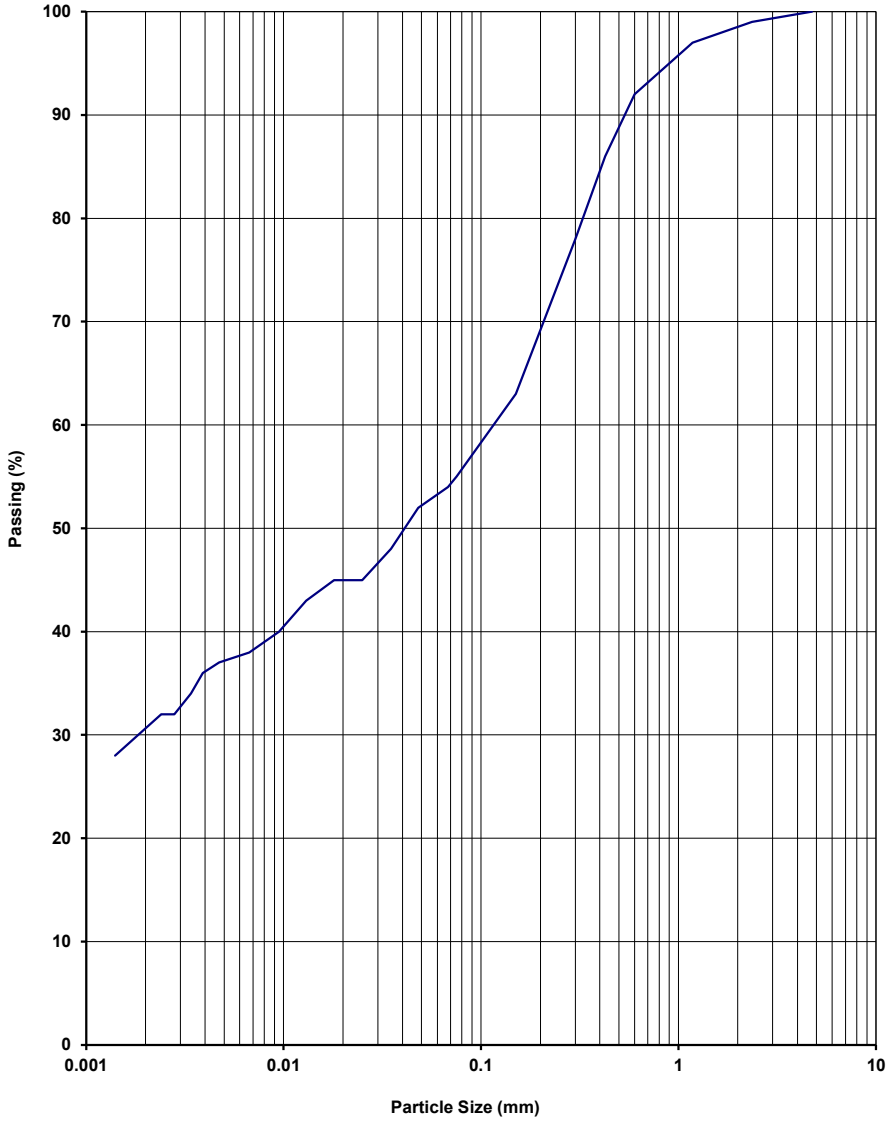
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Queens Park
WA 6107
Ph: +61 8 9258 8323

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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Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Park

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Laboratory No. 9926

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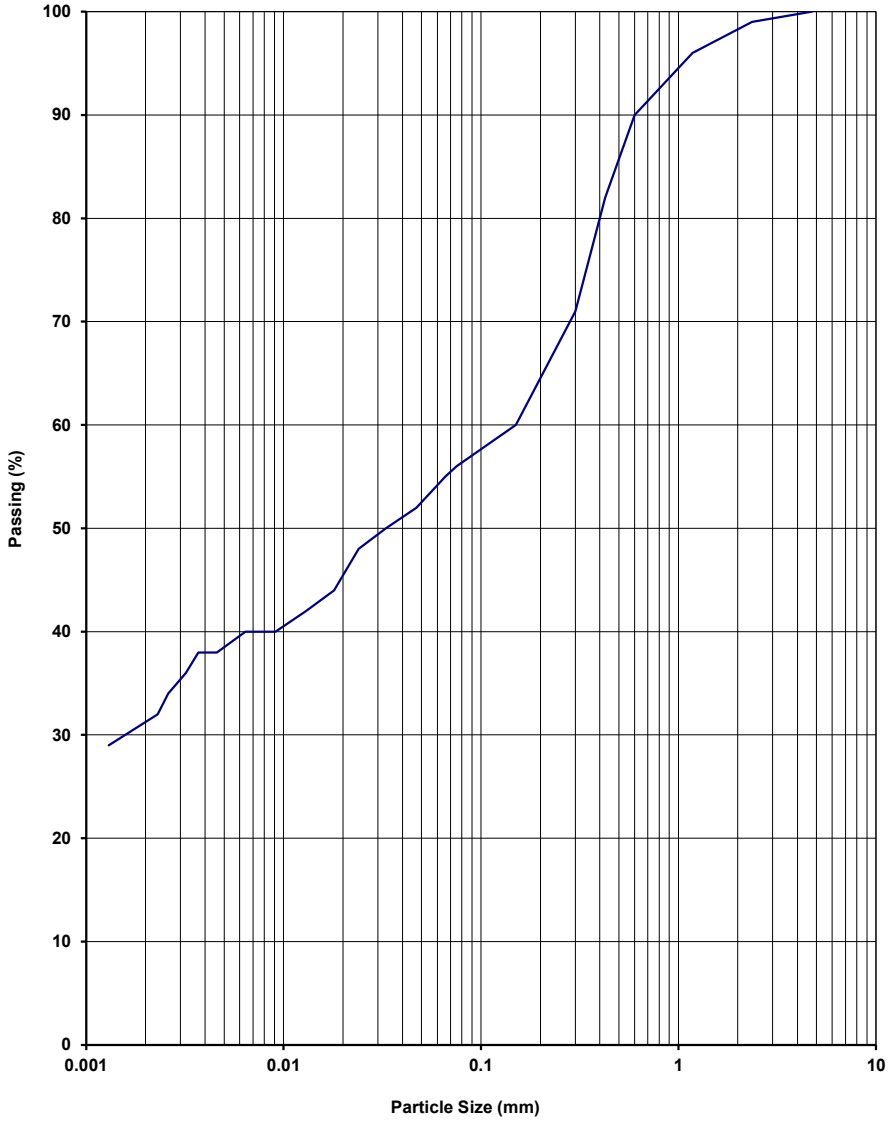
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Ph: +61 8 9258 8323

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.**	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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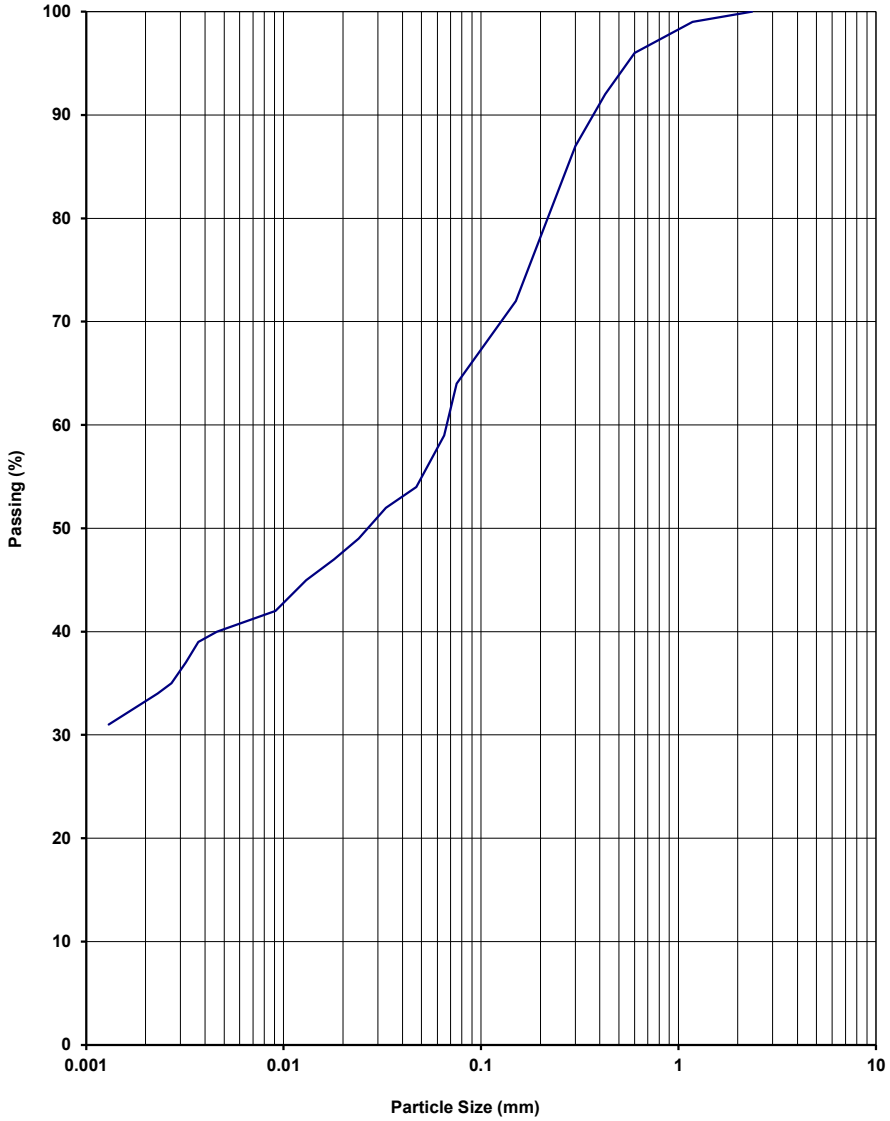
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PARTICLE SIZE DISTRIBUTION TEST REPORT

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

Sample/s supplied by the client

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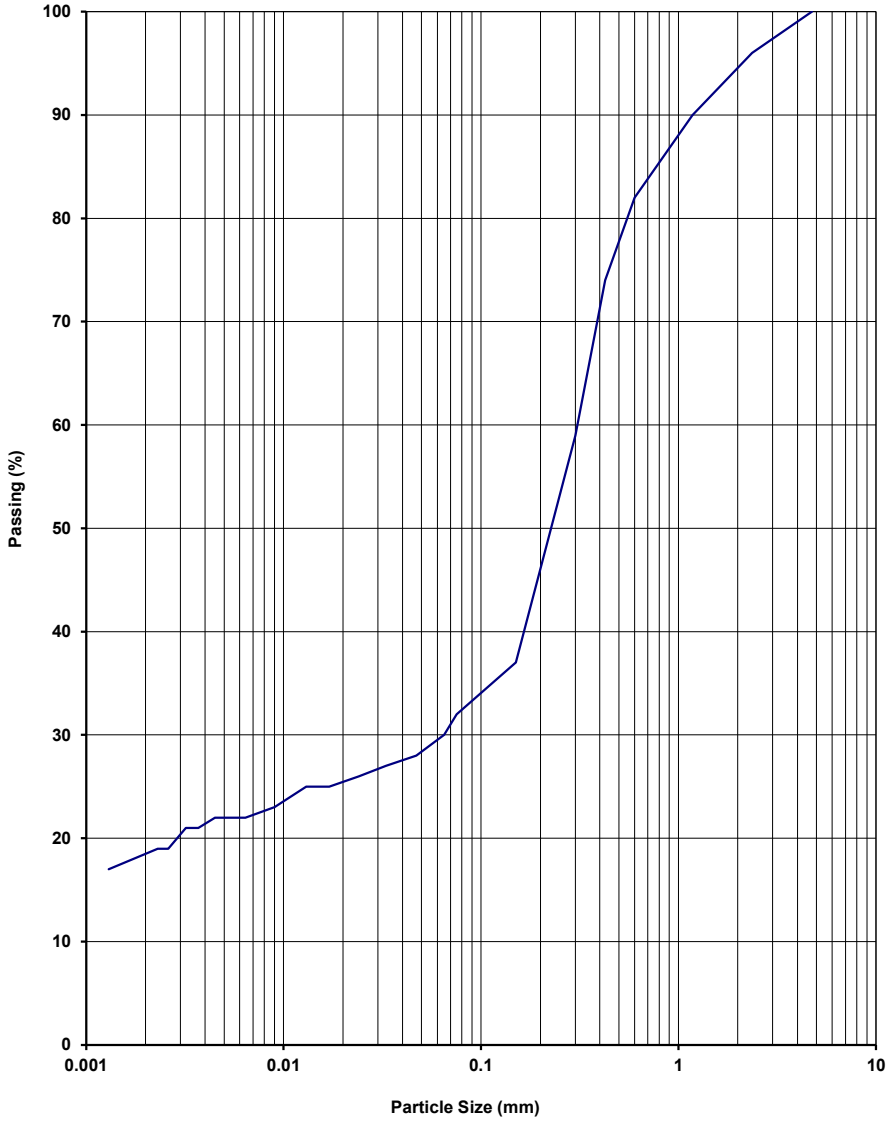
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Ph: +61 8 9258 8323

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.**	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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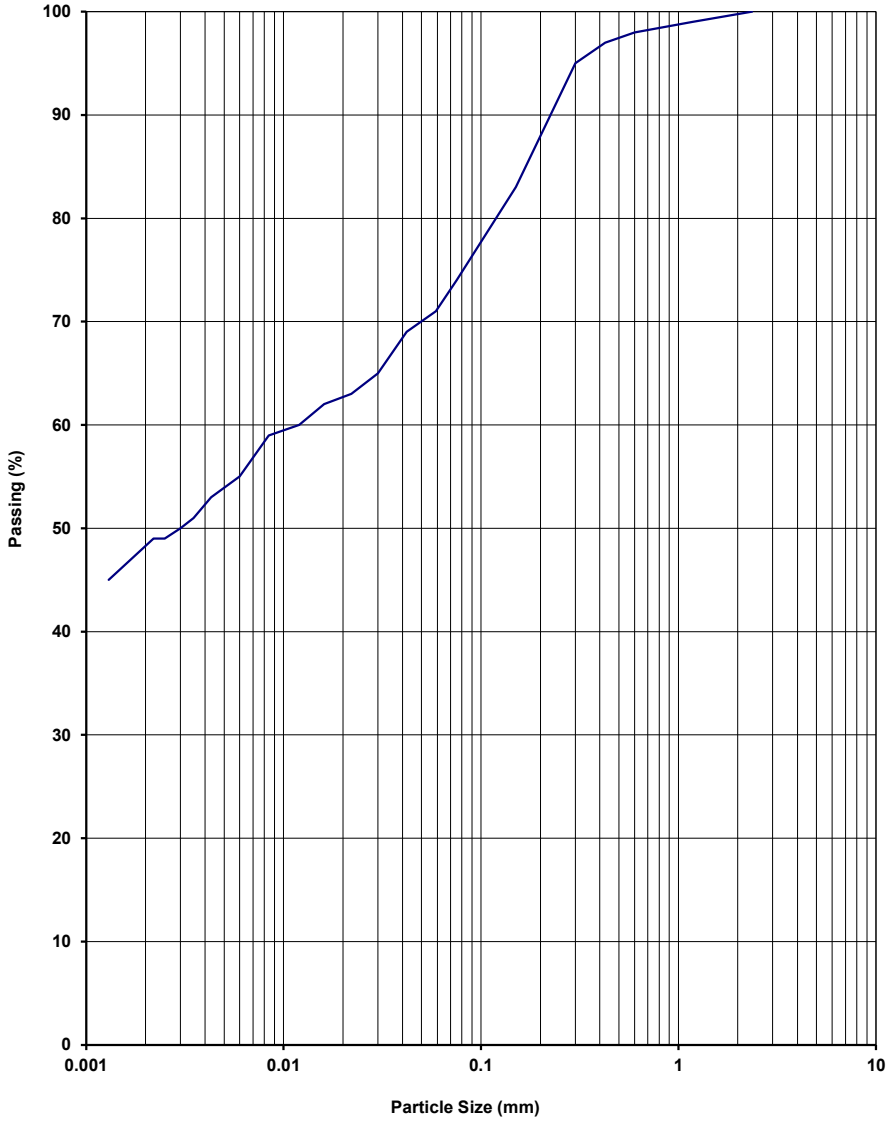
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PARTICLE SIZE DISTRIBUTION TEST REPORT

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

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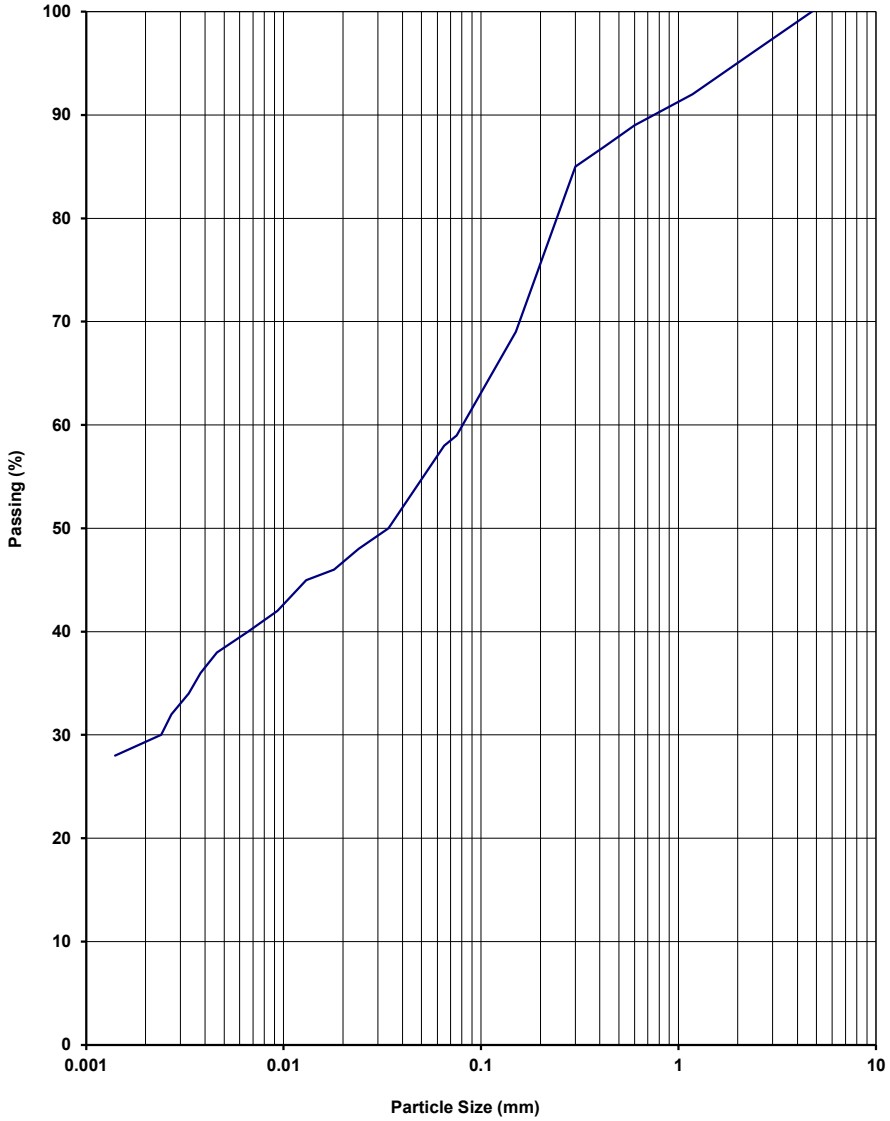
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PARTICLE SIZE DISTRIBUTION TEST REPORT

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

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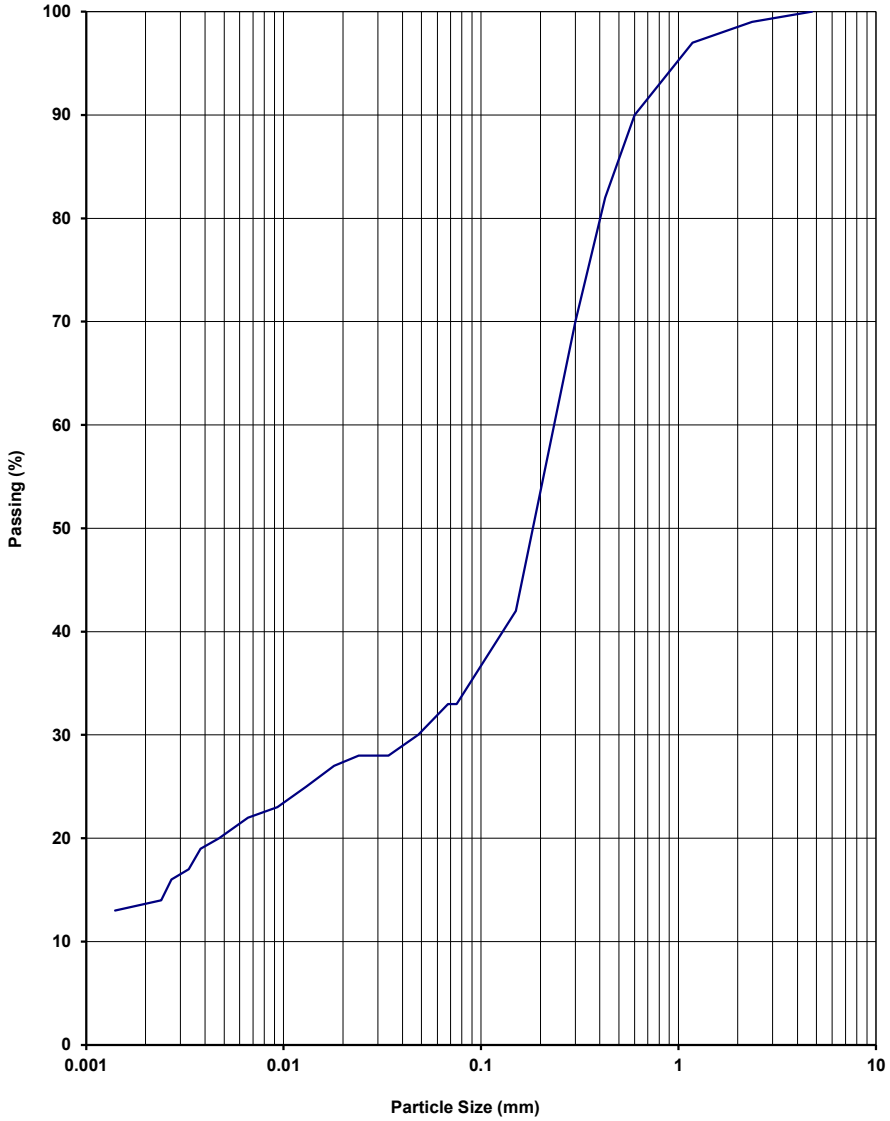
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PARTICLE SIZE DISTRIBUTION TEST REPORT

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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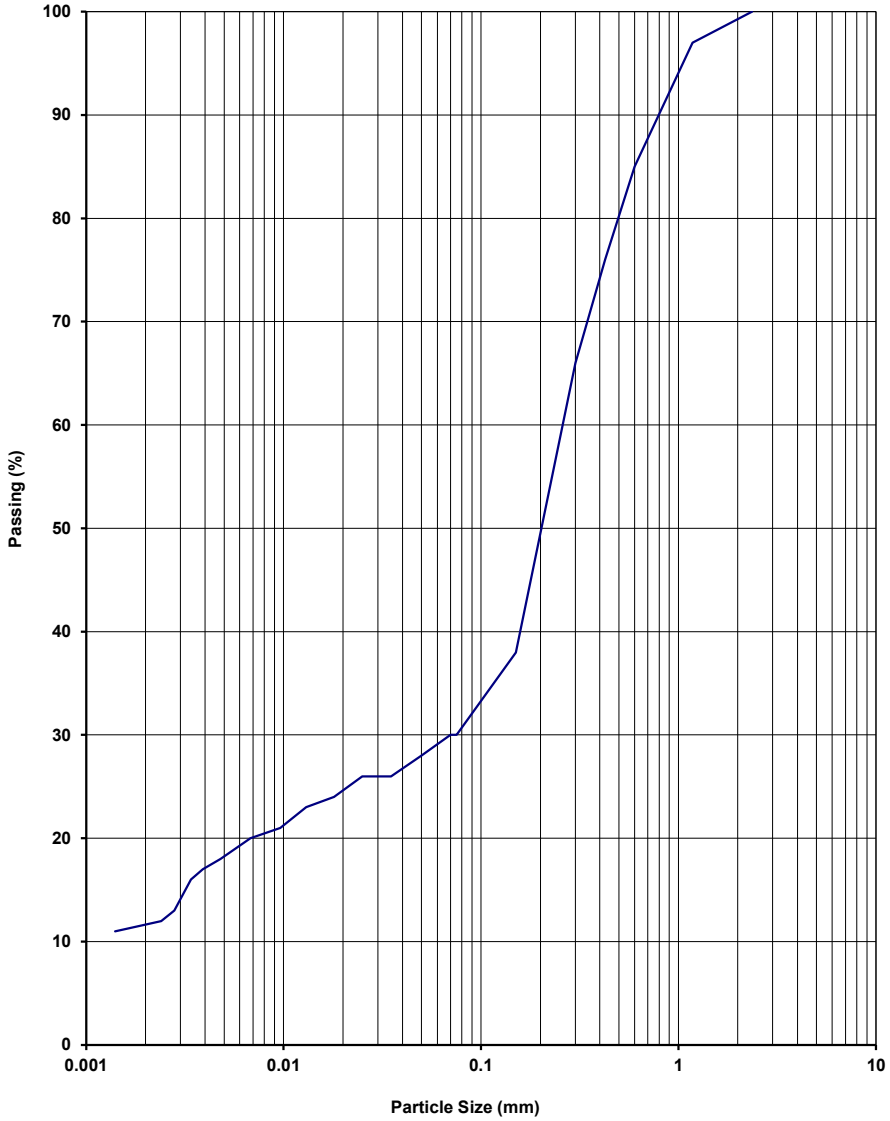
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Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

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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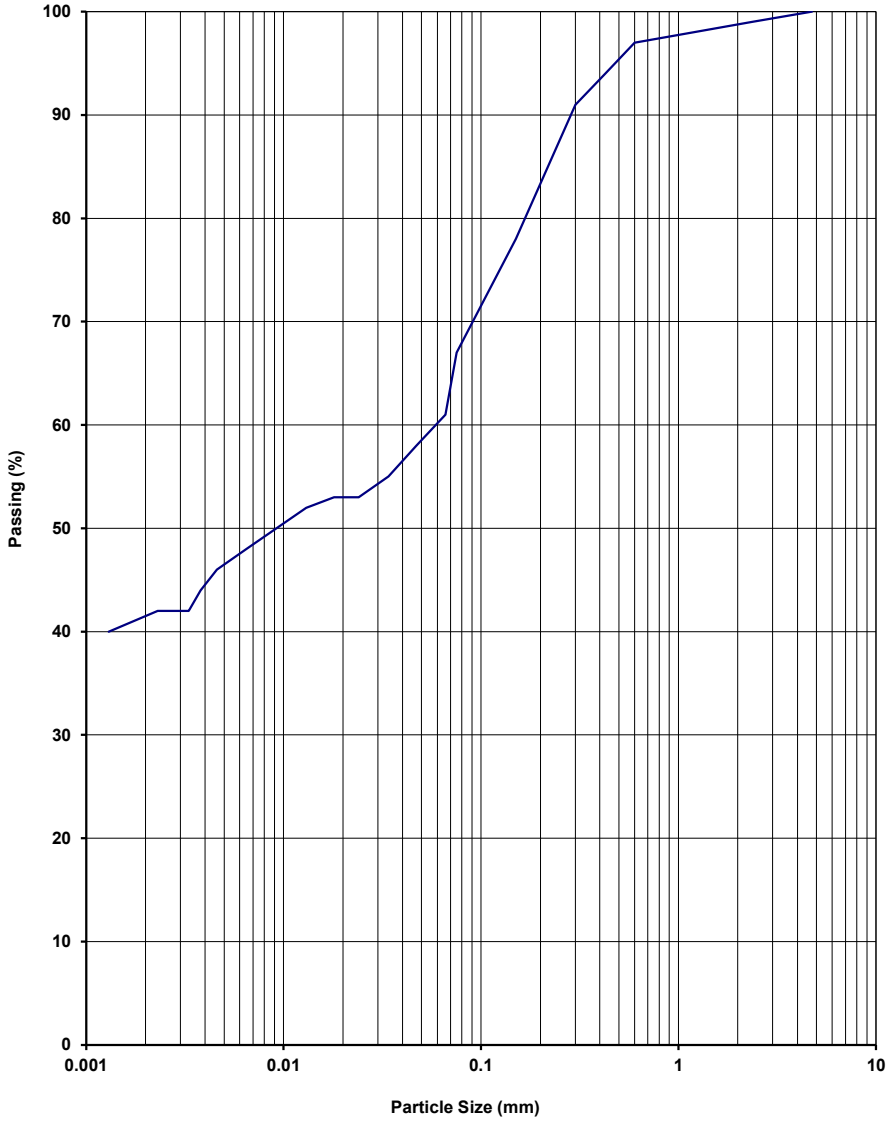
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PARTICLE SIZE DISTRIBUTION TEST REPORT

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

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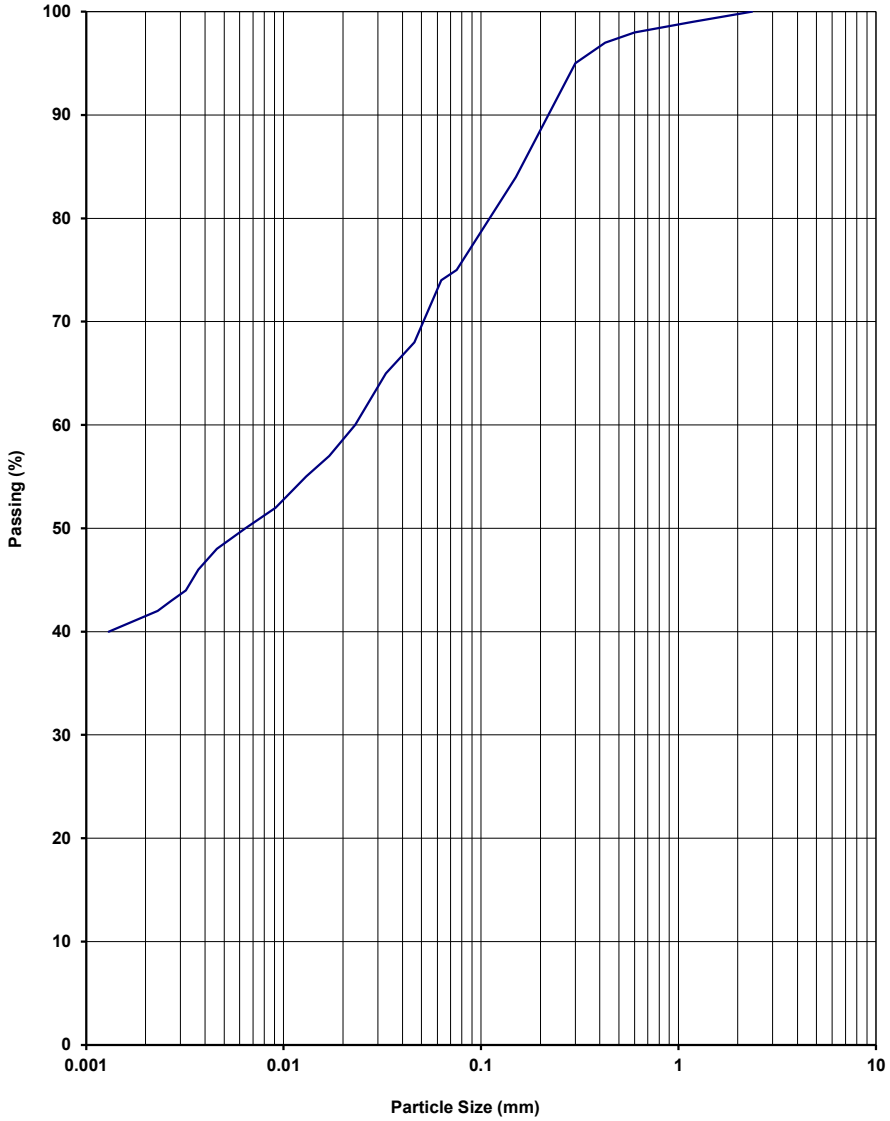
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PARTICLE SIZE DISTRIBUTION TEST REPORT

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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Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Park

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Laboratory No. 9926

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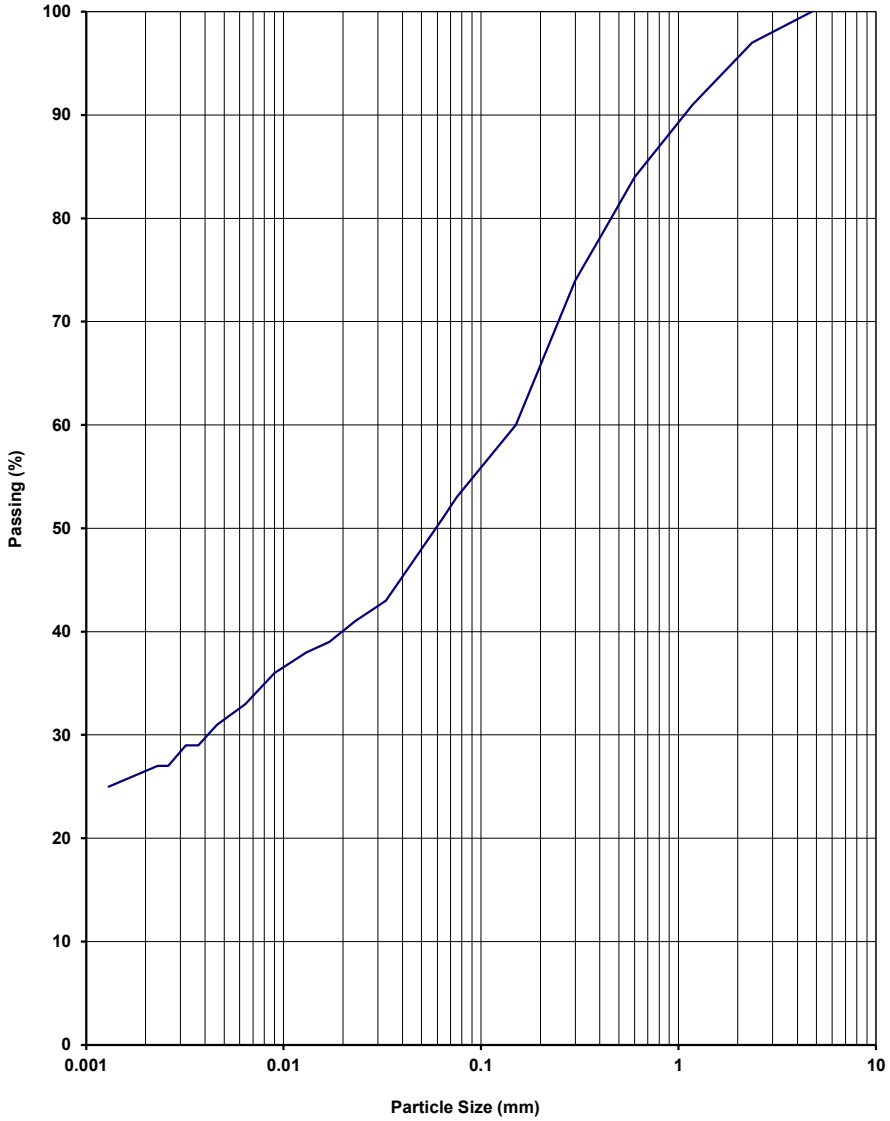
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PARTICLE SIZE DISTRIBUTION TEST REPORT

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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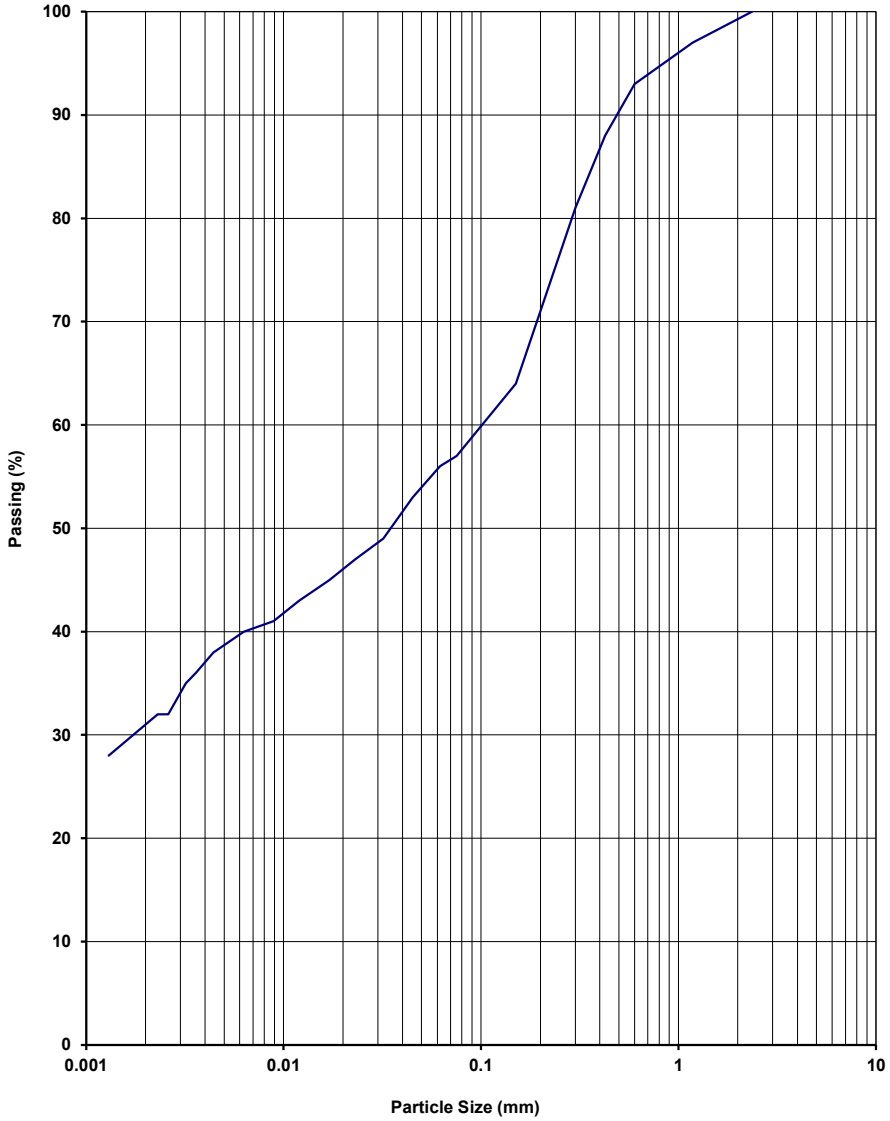
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PARTICLE SIZE DISTRIBUTION TEST REPORT

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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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

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)

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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)

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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)

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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)

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9.5.3 Permeability

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PERMEABILITY BY FALLING HEAD TEST REPORT

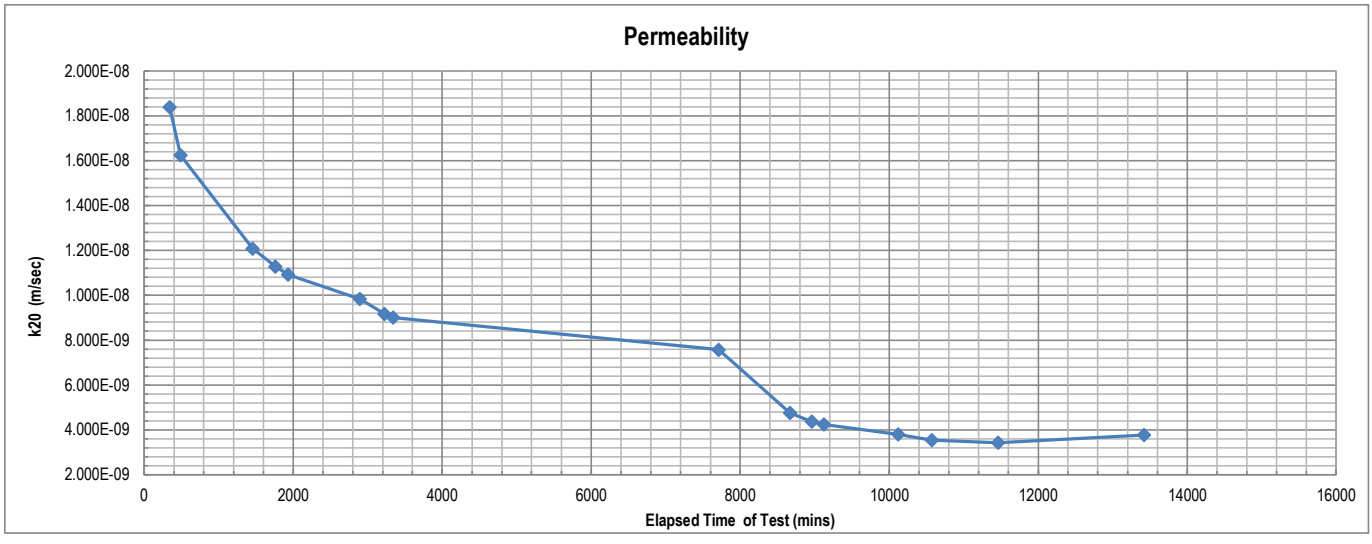
Test Method AS 1289 6.7.2, 5.1.1

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 $k_{(20)}$ = 3.8×10^{-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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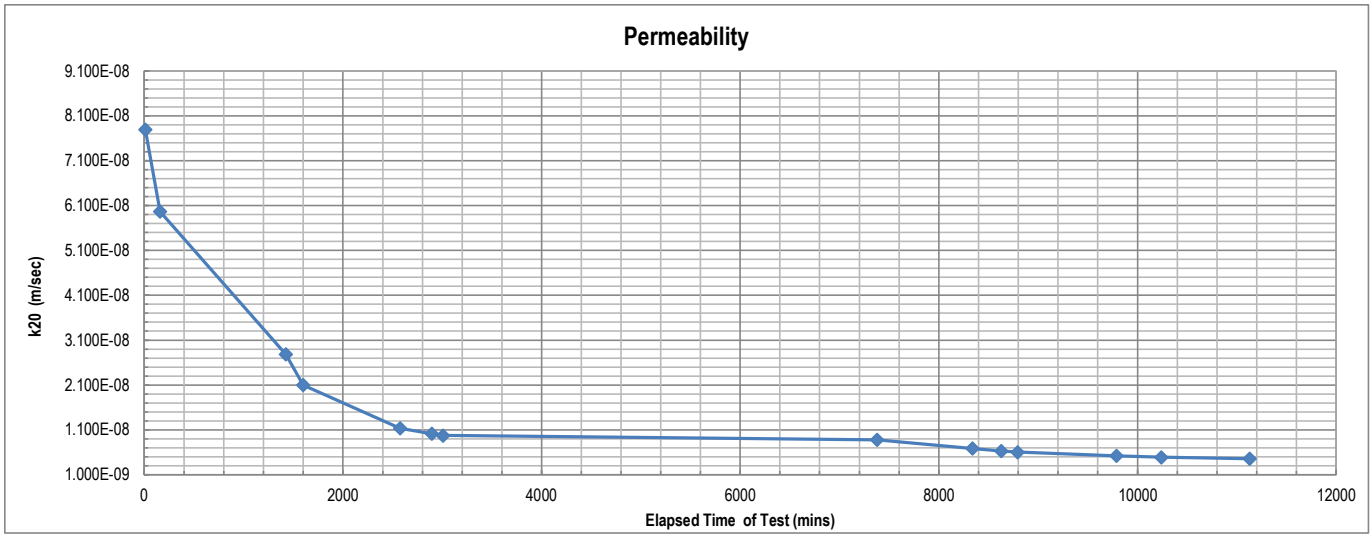
Test Method AS 1289 6.7.2, 5.1.1

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 $k_{(20)}$ = 4.6×10^{-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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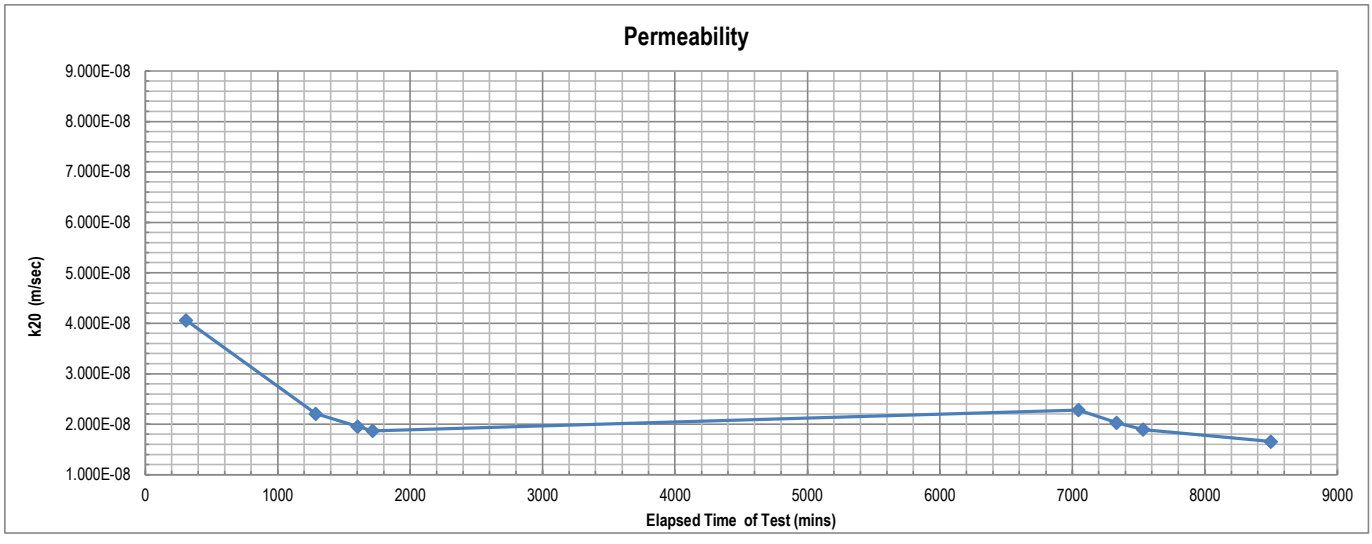
Test Method AS 1289 6.7.2, 5.1.1

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 $k_{(20)} =$ **1.7×10^{-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

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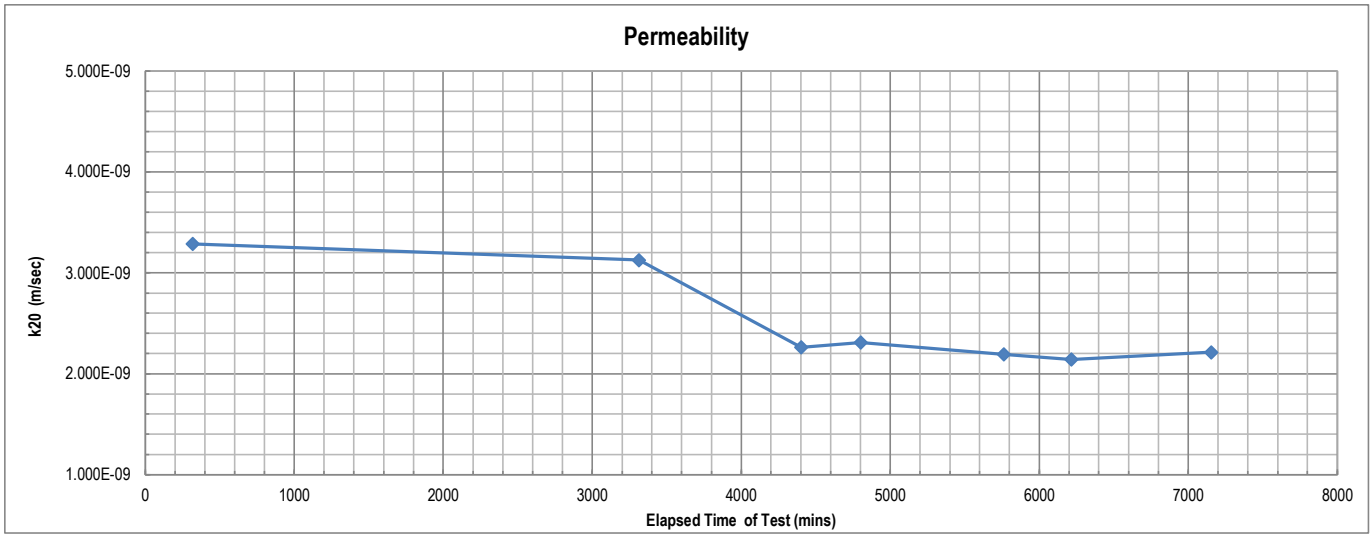
Test Method AS 1289 6.7.2, 5.1.1

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 $k_{(20)} =$ **2.2×10^{-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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Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Park

NATA
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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

9.5.4 Pinhole dispersion

Trilab
Soil Rock Calibration

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QLD 4034
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Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

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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Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Park

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

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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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Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Park

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Laboratory No. 9926

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

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_C2001	2 - 2020057_C2002	3 - 2020057_C2003	4 - 2020057_C2004	5 - 2020057_C2005	6 - 2020057_C2006	7 - 2020057_C2007
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_C2008	9 - 2020057_C2009	10 - 2020057_C2010	11 - 2020057_C2011	12 - 2020057_C2012	-	-
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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Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Park

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

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

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

N. Maddison

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

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Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

9.6 Attachment F: Levay and Co XRD report

LEVAY & CO. ENVIRONMENTAL SERVICES

Water Quality, Water Treatment and Environmental Pollution Research Laboratories

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).

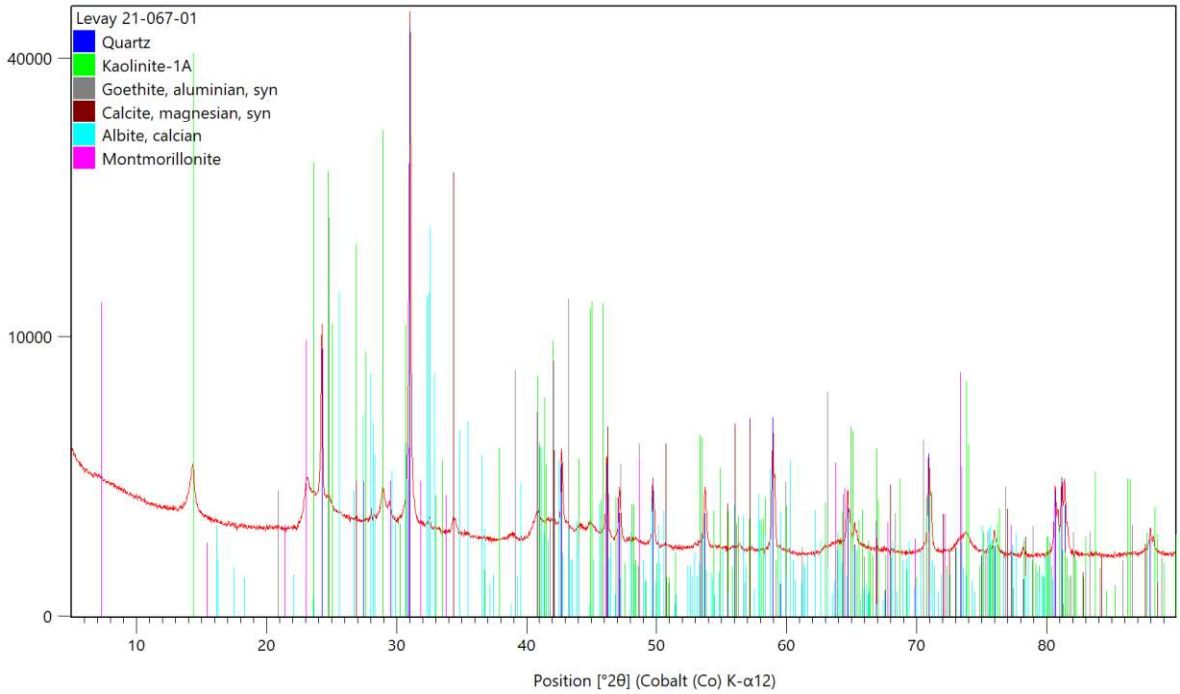
Note: The smectite (montmorillonite) content is estimated to be relatively low with the (001) peaks barely discernible on the traces obtained from the random powder sample mounts, however clay properties such as drying shrinkage will also be influenced by the poorly ordered character of the kaolinite and goethite present in the samples provided.

Table 2 QXRD results

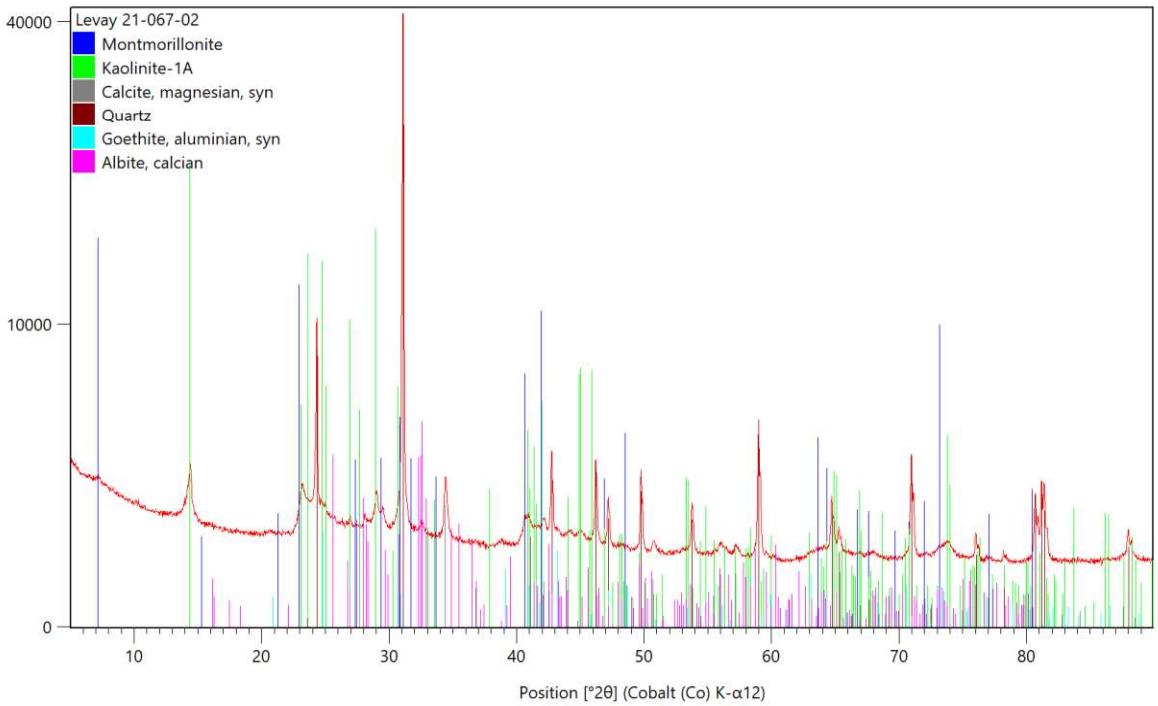
Phase	2020057-C2013 Weight %[1]	2020057-C2014 Weight %[1]	2020057-C2015 Weight %[1]	2020057-C2016 Weight %[1]
Quartz	57.9	56.2	56.8	50.8
Kaolinite – poorly ordered*	27.6	25.2	23.5	21.4
Goethite – poorly ordered*	6.6	6.9	6.4	5.9
Albite	2.6	3	4.8	8.4
Calcite	0.6	3.1	2.4	5.2
Microcline	2.7	2.7	2.7	2.6
Smectite (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

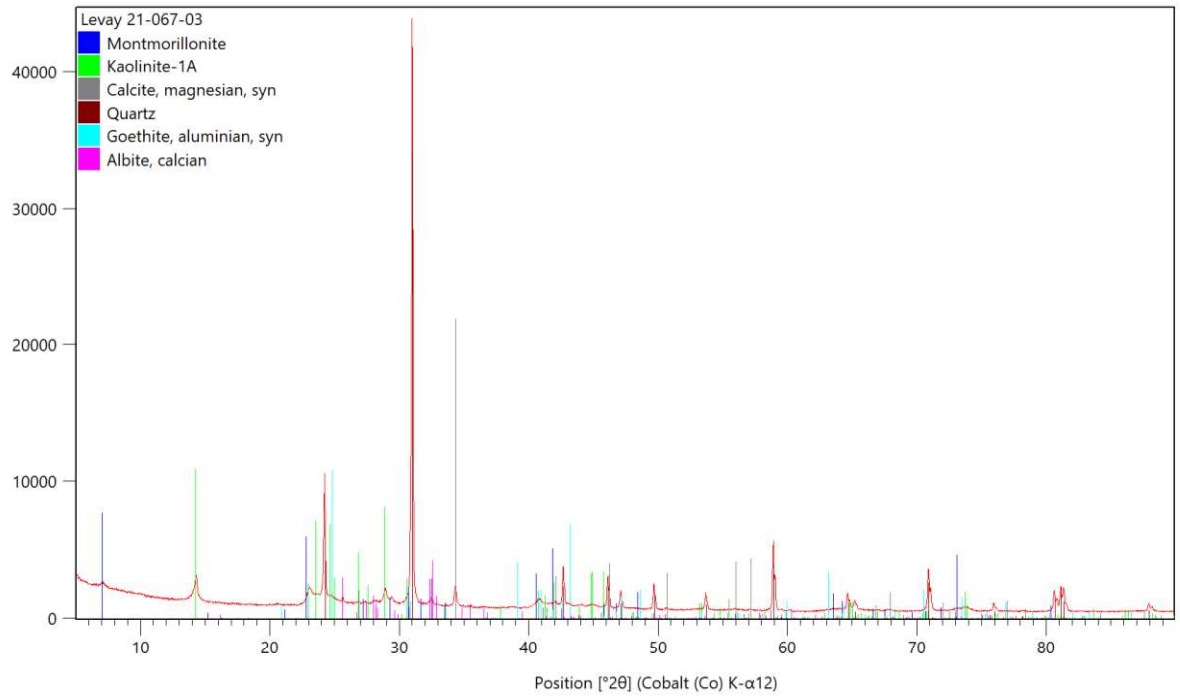
Results Graphical – Phase ID



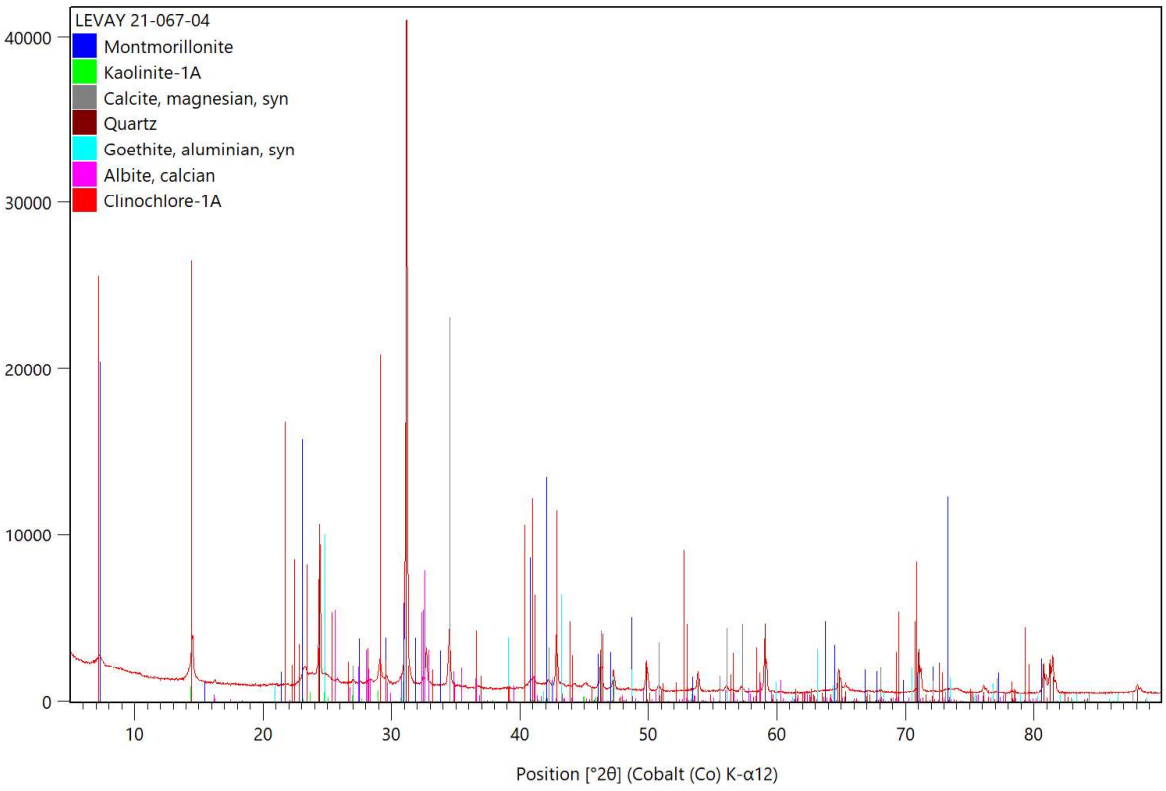
XRD trace obtained from #2020057-C2013 showing peaks indexed for the main phases identified.



XRD trace obtained from #2020057-C2014 showing peaks indexed for the main phases identified.

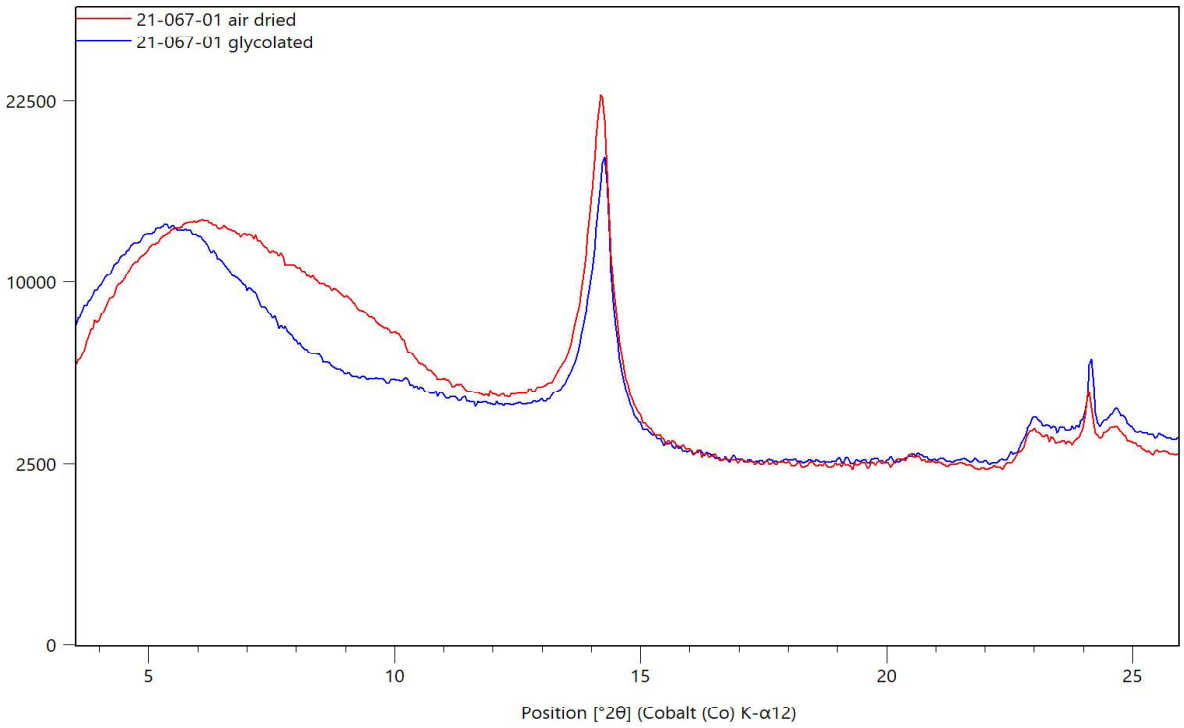


XRD trace obtained from #2020057-C2015 showing peaks indexed for the main phases identified.

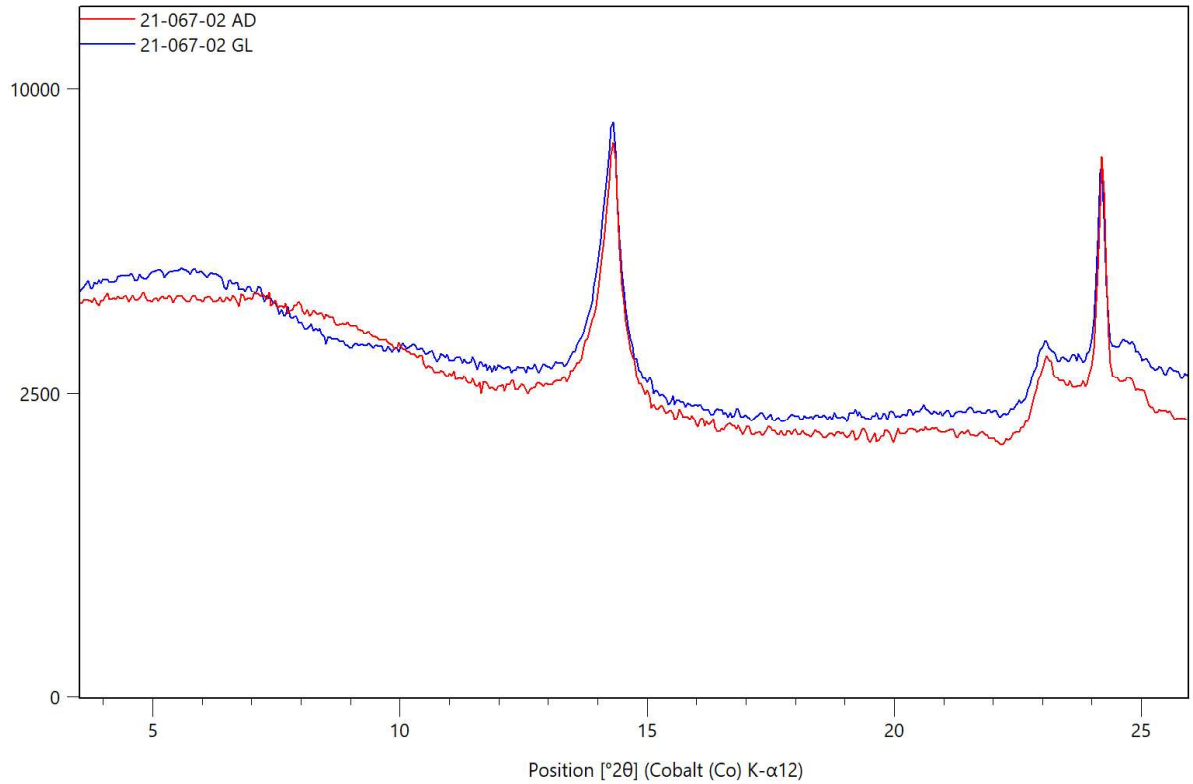


XRD trace obtained from #2020057-C2016 showing peaks indexed for the main phases identified.

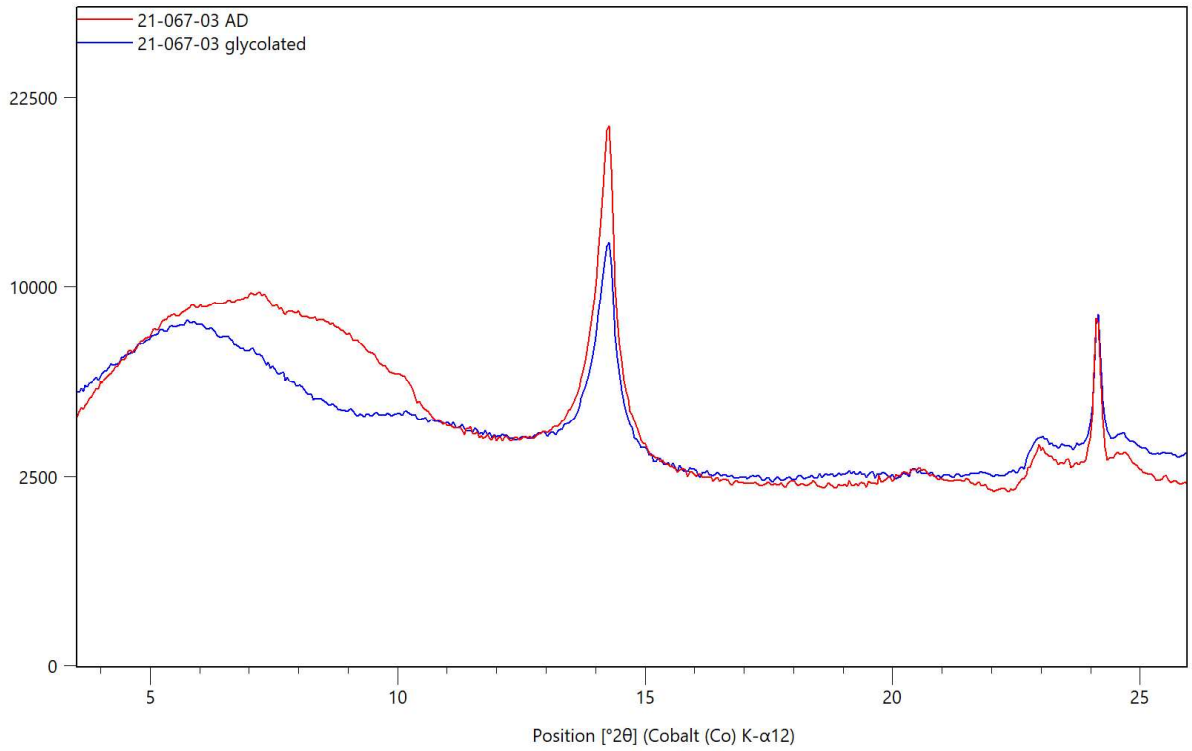
Sedimented Samples – note the clay fraction greatly concentrated and orientated.



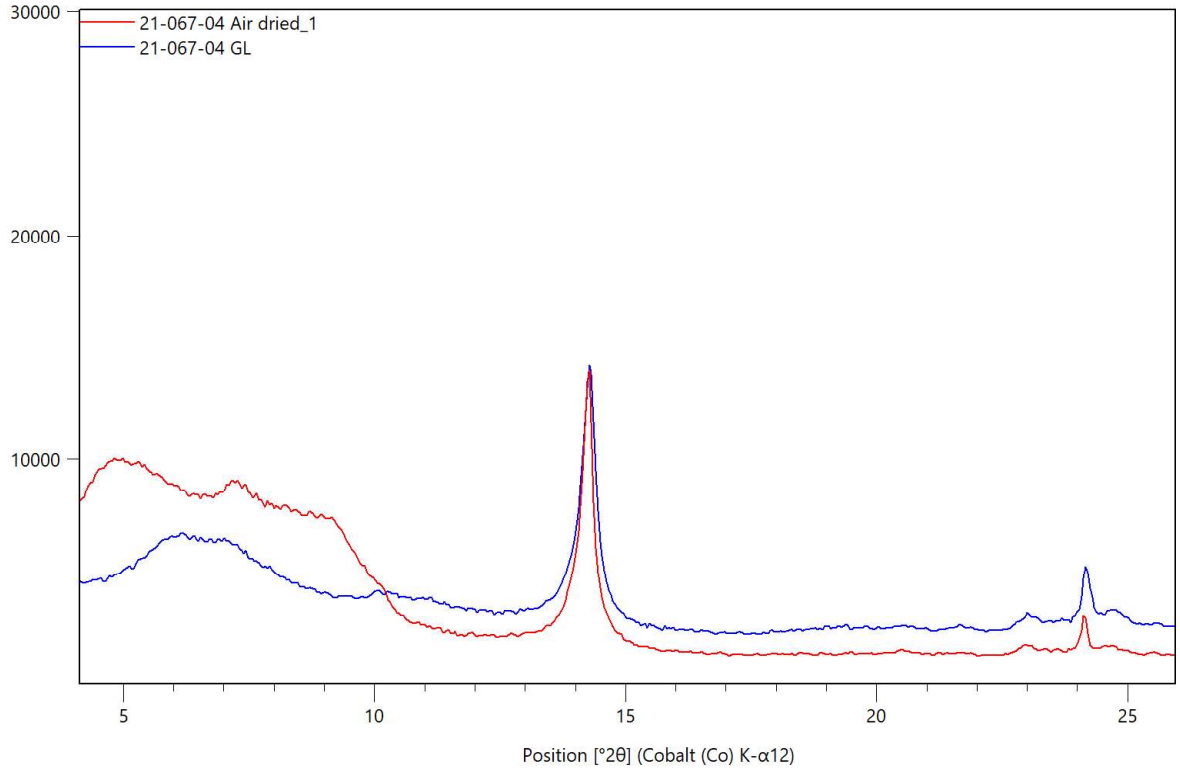
#2020057-C2013 demonstration of presence of smectite (montmorillonite) in the sample supplied – behaviour on glycolation



#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

45 Gladstone St
East Perth WA 6006
(08) 9228 3060
(08) 9228 3210
admin@soilwatergroup.com
www.soilwatergroup.com

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



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.

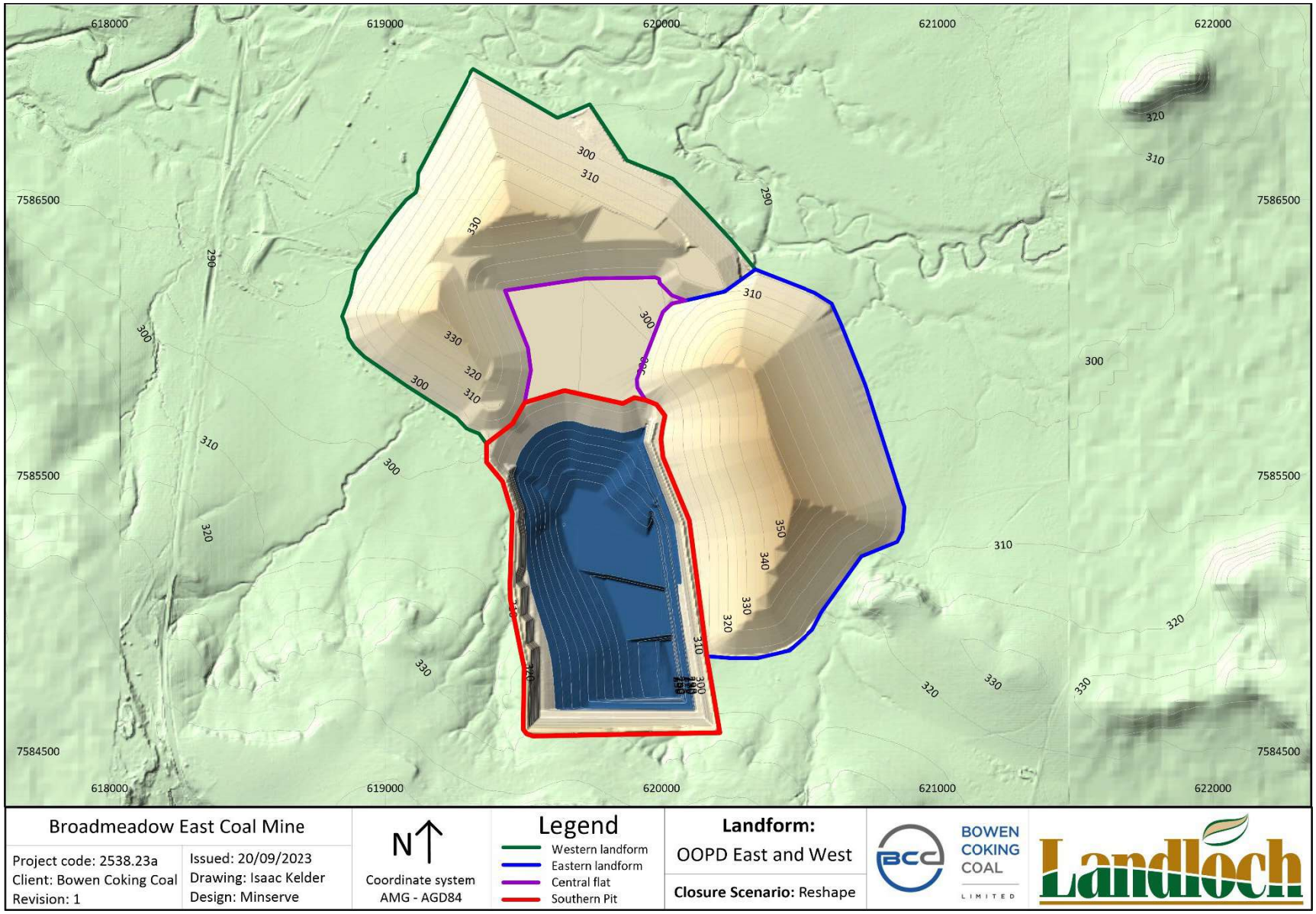


Figure 2: Areas of the proposed OOPD East and West rehabilitation design.

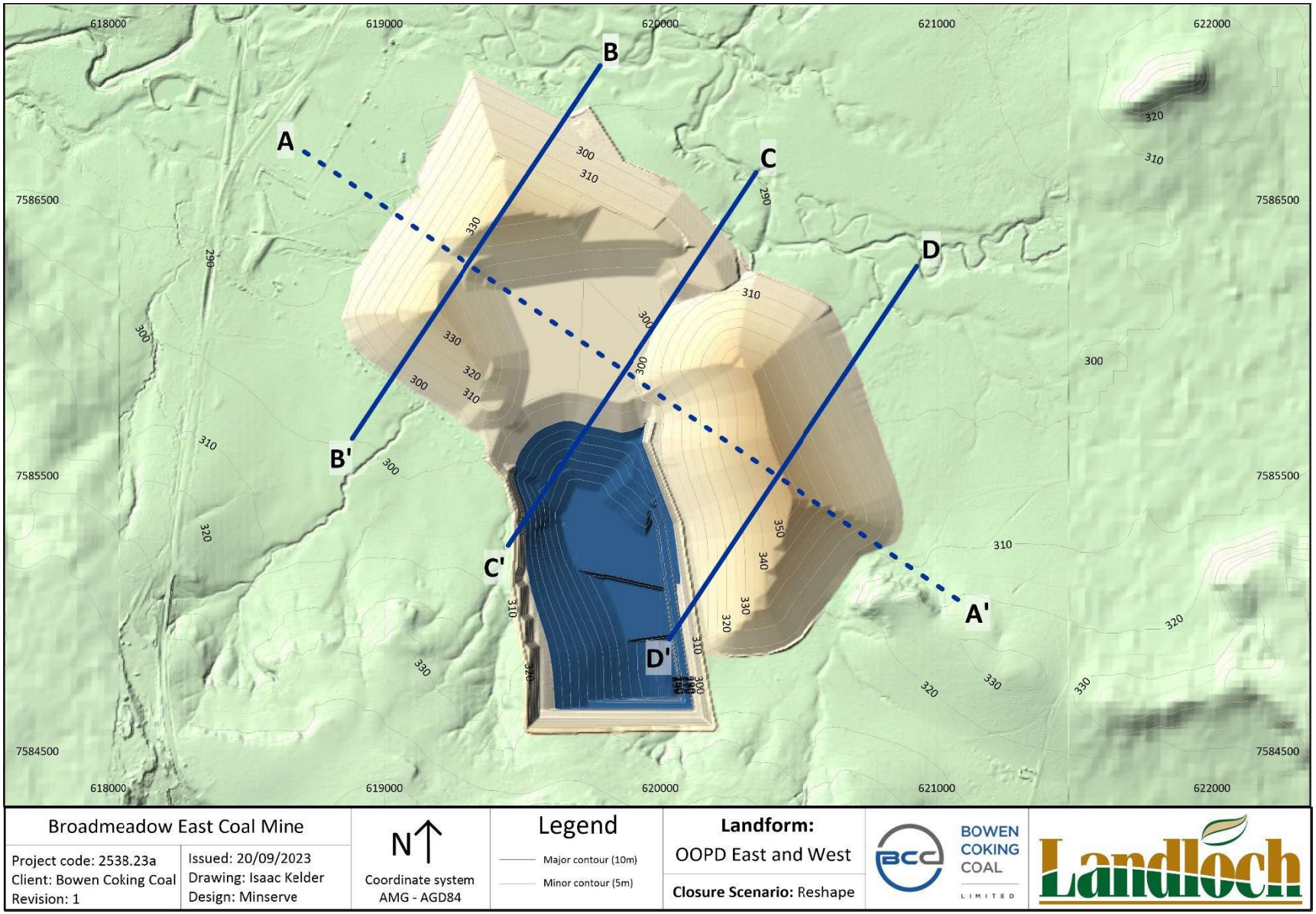


Figure 3: Proposed Rehabilitation design for OOPD East and West.

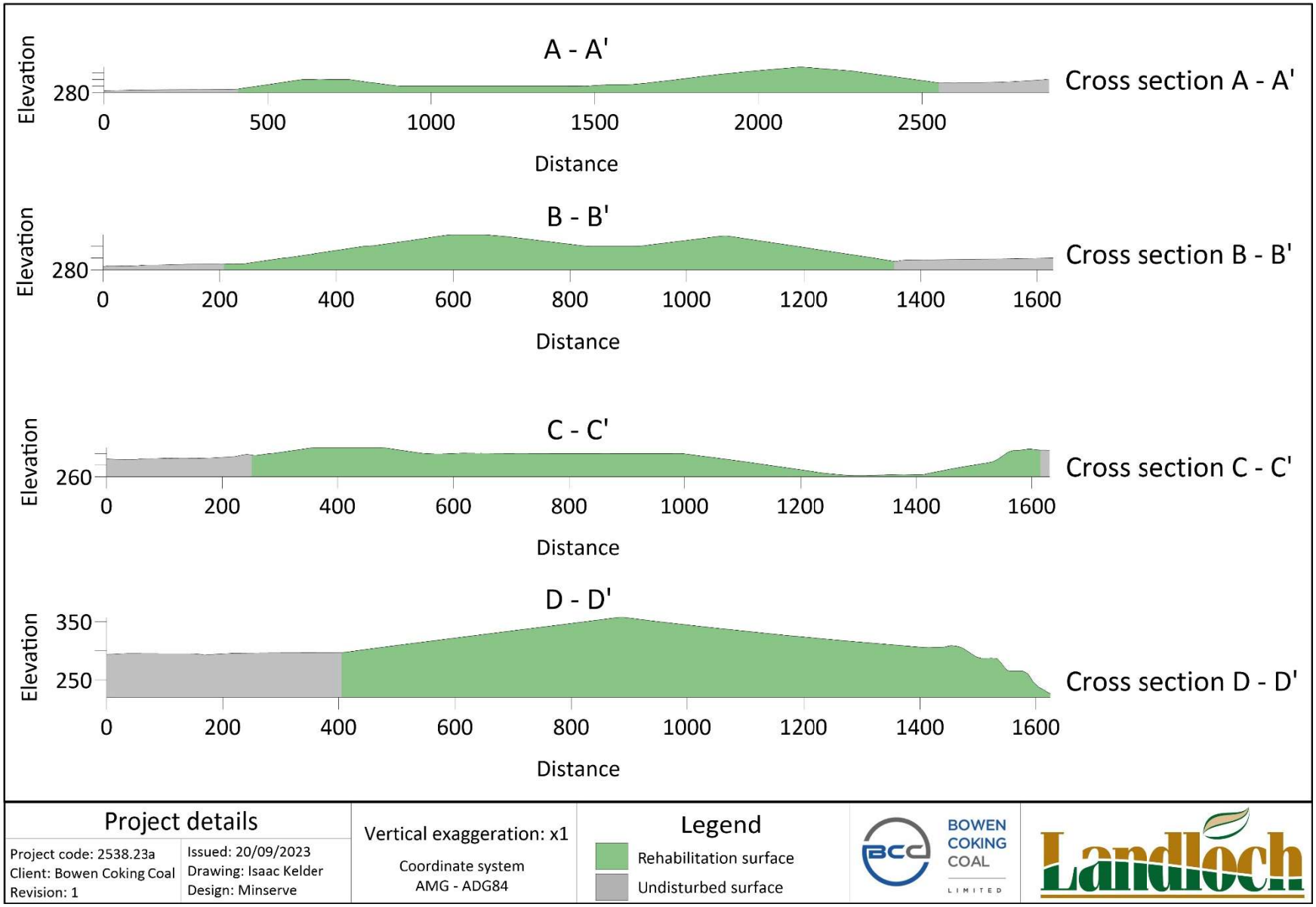


Figure 4: Cross sections of proposed rehabilitation design for OOPD East and West.

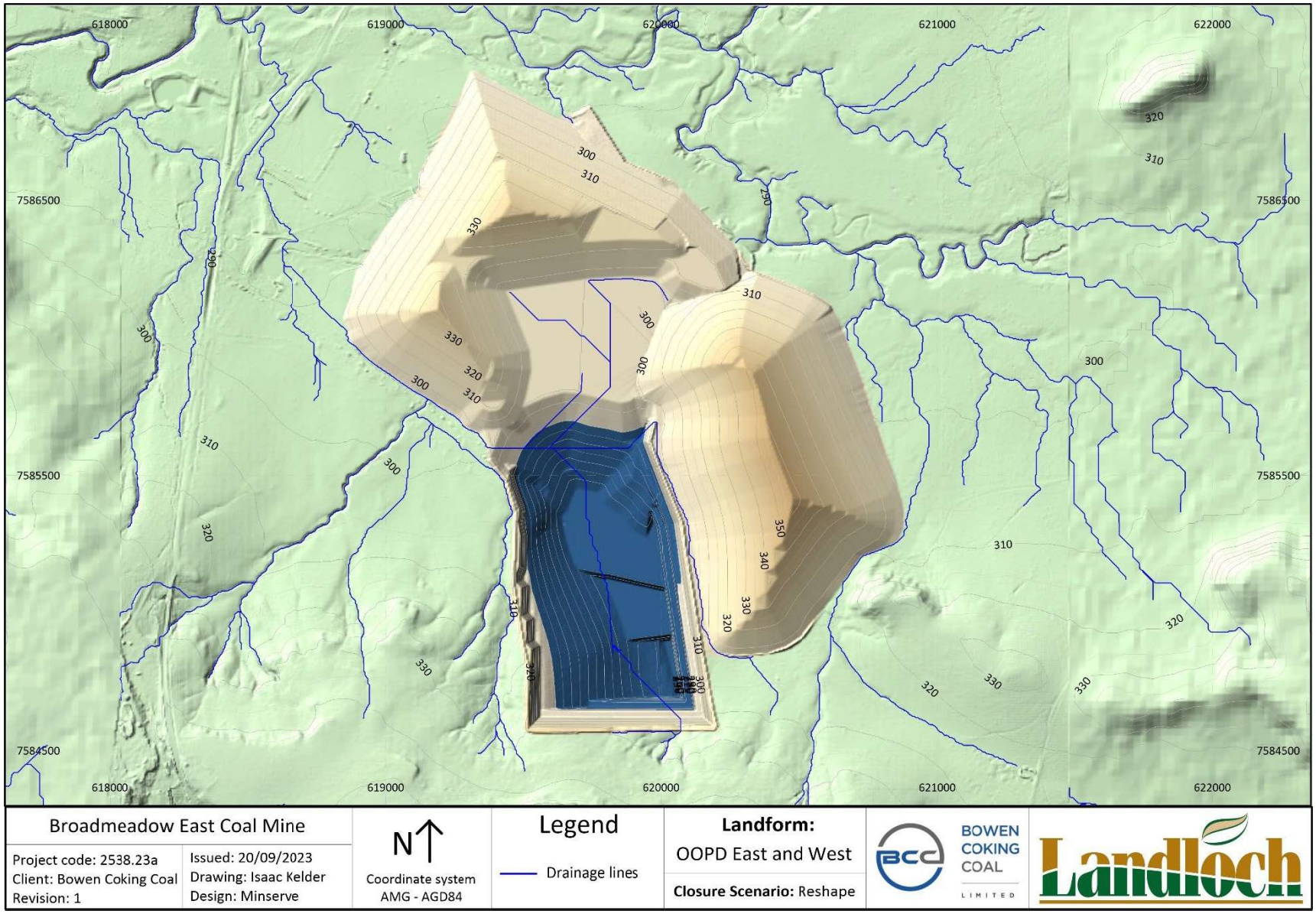


Figure 5: Drainage lines of the proposed rehabilitation design.

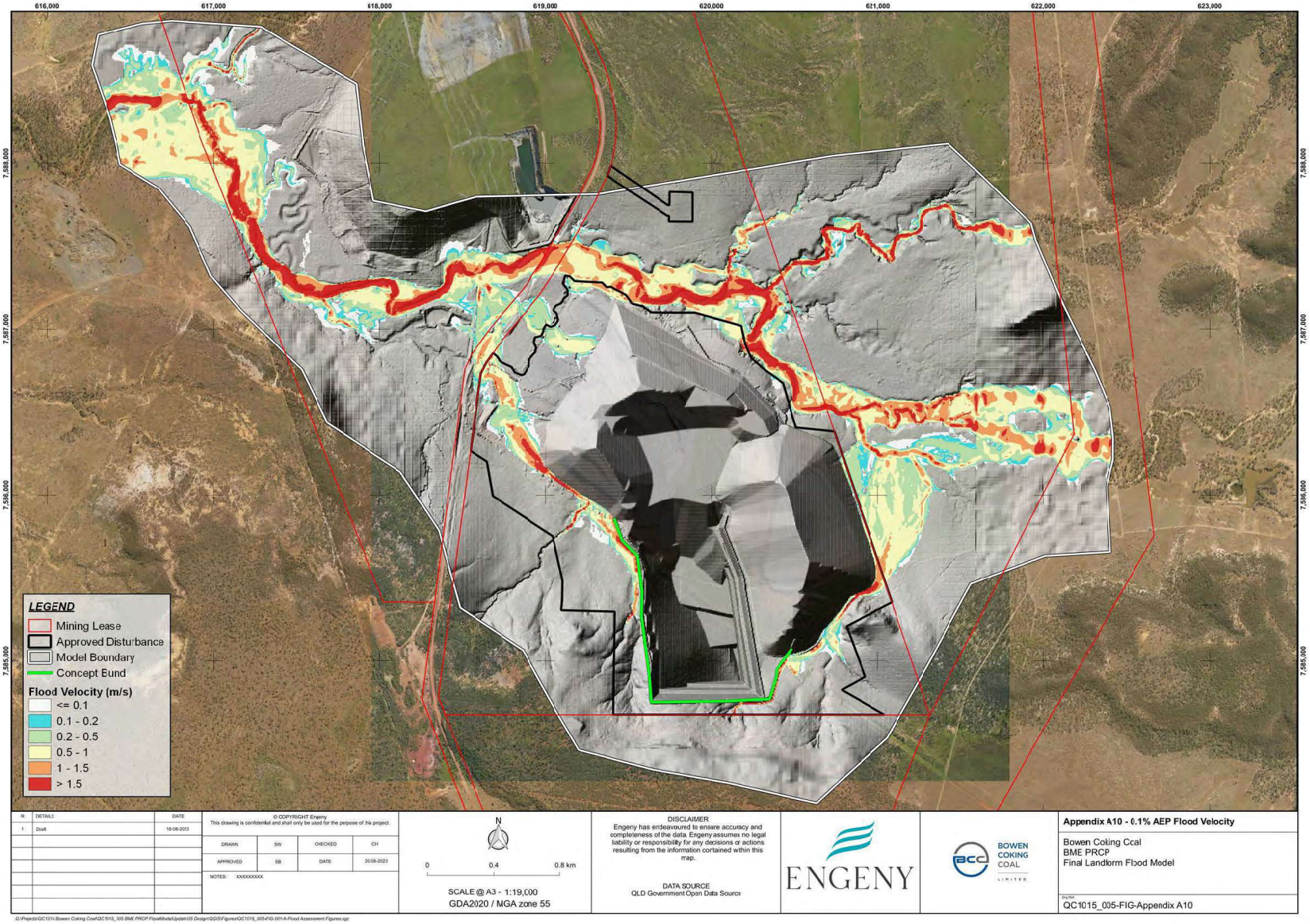


Figure 6: Surface water modelling showing velocities (m/s) for a 0.1% AEP for proposed rehabilitation design (Engeny 2023)

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).

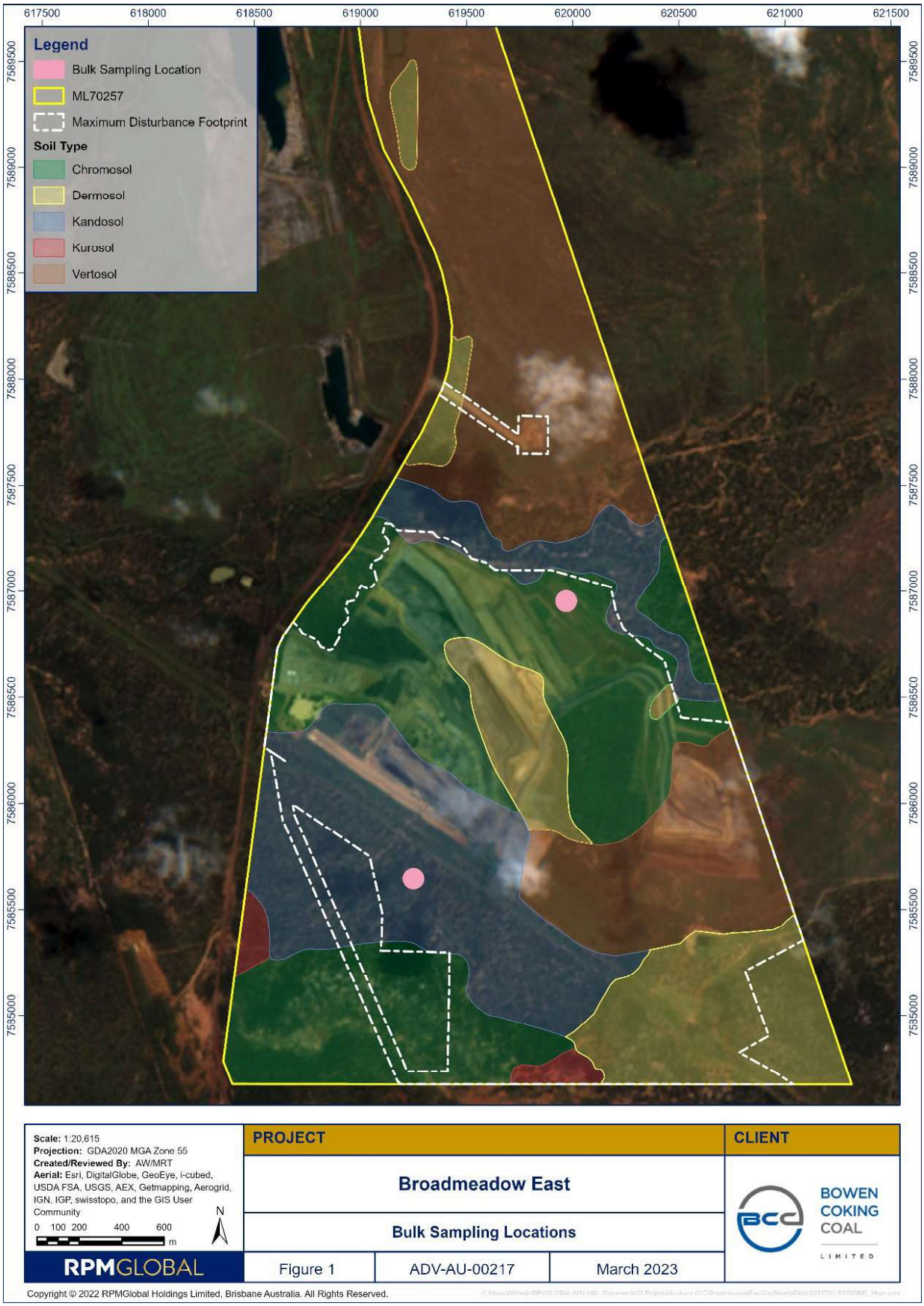


Figure 7: Sample locations for the Chromosol/Vertosol and the Kandosol.



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/m^4	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.

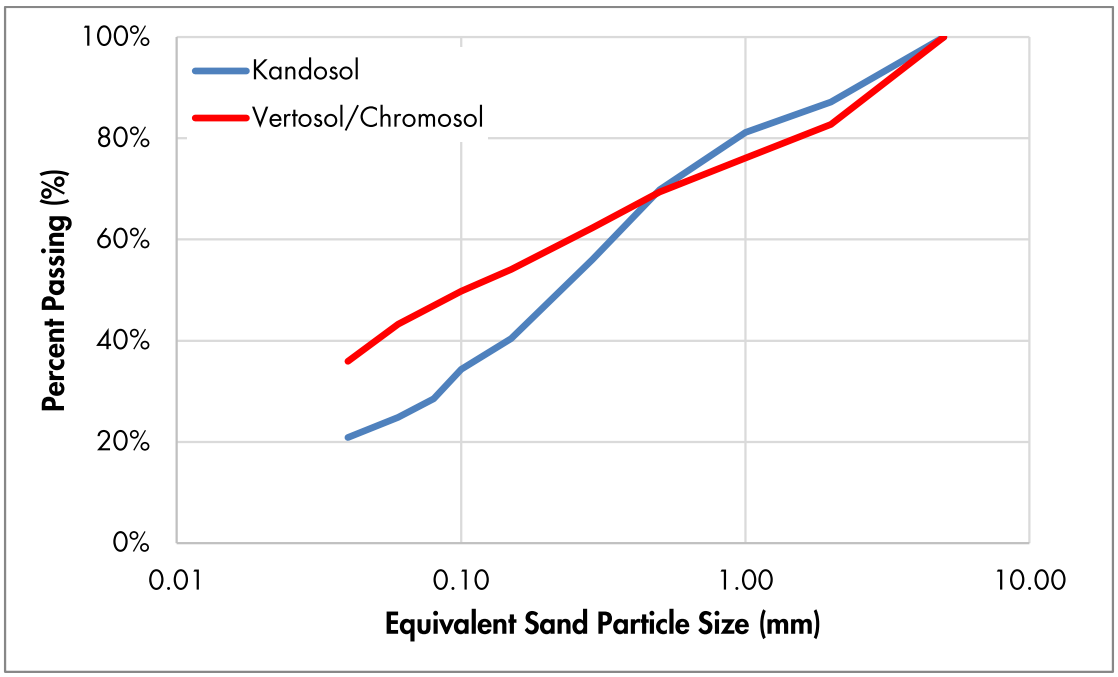


Figure 9: Sediment size distribution for the Kandosol and Vertosol/Chromosol.

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 or NUMA	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R1 (PMLU)	OOPD	PMLU -Low intensity grazing	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 (PMLU)	OOPD	PMLU -Low intensity grazing	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 (PMLU)	OOPD	PMLU -Low intensity grazing	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 or NUMA	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R4 (PMLU)	OOPD	PMLU -Low intensity grazing	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 (PMLU)	OOPD	PMLU -Low intensity grazing	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 (PMLU)	Northern Pit (partial backfill)	PMLU -Low intensity grazing	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.	Rare	Minor	Risk Eliminated	Annual site inspections to identify any signs of unauthorised access.
R7 (PMLU)	Northern Pit	PMLU -Low intensity grazing	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.	Possible	Moderate	Risk Eliminated	• Landform compliance audit against design criteria by AQP. •Rehabilitation performance monitoring, including erosion parameters.
R8 (PMLU)	Northern Pit	PMLU -Low intensity grazing	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.	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.

Ref No.	Domain	PMLU or NUMA	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R9 (PMLU)	Northern Pit	PMLU -Low intensity grazing	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.	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 (PMLU)	Central Pit	PMLU -Low intensity grazing	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.
R11 (PMLU)	Central Pit	PMLU -Low intensity grazing	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 (PMLU)	Central Pit	PMLU -Low intensity grazing	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 (PMLU)	Central Pit	PMLU -Low intensity grazing	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.

Ref No.	Domain	PMLU or NUMA	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R14 (PMLU)	Central Pit	PMLU -Low intensity grazing	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.
R15 (NUMA)	Southern Void	NUMA (residual void)	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 (NUMA)	Southern Void	NUMA (residual void)	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 (NUMA)	Southern Void	NUMA (residual void)	Physical Stability	All	Erosion from the water storage areas 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 NUMA 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 or NUMA	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R18 (NUMA)	Southern Void	NUMA (residual void)	Hydrology	Closure	The southern void long term water quality target is not achieved resulting in a final landform that does allow for use as cattle watering.	• 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 (PMLU)	Water Management Infrastructures (to be rehabilitated)	PMLU -Low intensity grazing	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 (PMLU)	Water Management Infrastructures (to be rehabilitated)	PMLU -Low intensity grazing	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 (PMLU)	Water Management Infrastructures (to be rehabilitated)	PMLU -Low intensity grazing	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	Possible	Moderate	Medium	Remove all potentially hazardous water/sediment from the facility prior to rehabilitation works.	Unlikely	Minor	Low	• Annual site inspections.
R22 (PMLU)	Water Management Infrastructures (to be rehabilitated)	PMLU -Low intensity grazing	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 (PMLU)	Infrastructure (MIA/explosives/exploration)	PMLU -Low intensity grazing	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 or NUMA	Aspect	Mine Phase	Event or Activity	Risk Pathway	Impact	Likelihood	Consequence	Inherent Risk	Treatment	Likelihood	Consequence	Residual Risk	Monitoring
R24 (PMLU)	Infrastructure (MIA/explosives/exploration)	PMLU -Low intensity grazing	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 (PMLU)	Infrastructure (MIA/explosives/exploration)	PMLU -Low intensity grazing	Ecosystem Function	Closure	Rehabilitation does not meet the target vegetation criteria in previous infrastructure 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 amelioration if required from any soil sampling program. • Monitoring and reporting.	Unlikely	Minor	Low	• Rehabilitation performance assessment.
R26 (PMLU)	Roads and tracks	PMLU -Low intensity grazing	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 (PMLU)	Roads and tracks	PMLU -Low intensity grazing	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 (PMLU)	Roads and tracks	PMLU -Low intensity grazing	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.

RPM has prepared this risk assessment for Coking Coal One Pty Ltd only in accordance with the terms and conditions of its engagement and is current as at 20 January 2023. This document must be read in its entirety and subject to all limitations, assumptions and conditions as set out in the engagement document. RPM does not authorise reliance on this document by any third party and will not be liable for any loss or damage suffered by a third party relying on this Memorandum.

BOWEN COKING COAL LIMITED

Biodiversity Management Plan – Broadmeadow East Mine

BOWEN COKING COAL LIMITED AND WHOLLY OWNED SUBSIDIARY COKING COAL ONE PTY LTD

VERSION 1 | September 2022



BROADMEADOW EAST PROJECT

Biodiversity Management Plan

Client: Bowen Coking Coal Limited and wholly owned subsidary Coking Coal One Pty Ltd

Report Name: Biodiversity Management Plan– Broadmeadow East Mine

Job Number: ADV-AU-00217

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Appendix A Biodiversity Value Profiles

1 Introduction

Bowen Coking Coal Limited (BCC) and its wholly owned subsidiary Coking Coal One Pty Ltd ("CCO" or "the Proponent") commissioned RPM Advisory Services Pty Ltd ("RPM") to prepare the Biodiversity Management Plan (BMP) to support proposed activities to be undertaken for the Broadmeadow East Coal Mine ("the Project") in the northern portion of Bowen Basin, Queensland.

This plan has been developed in place of a Species Impact Management Plan, which is typically developed to satisfy conditions outlined in a Project's Referral under the *Environment Protection and Biological Conservation Act 1999* (EPBC Act). Despite the Project not requiring a Species Impact Management Plan, CCO have recognised the need for the Project to have such a plan. They have chosen to develop the BMP to outline how they plan to avoid, manage and mitigate identified threatened biodiversity values that are known to occur, or may occur within the Project area.

Using the information provided in the Baseline Ecology Assessment Report (Nitro Solutions, 2021), several biodiversity values of importance were identified through the Project area because they are:

- Listed as threatened under National (EPBC Act) or State legislation (*Nature Conservation Act 1992* (NC Act);
- A 'prescribed environmental matter' for which the Project must demonstrate that a significant residual impact under the *Environmental Offsets Act 2020* has not occurred.

2 Purpose and Scope

The purpose of this BMP is to avoid, minimize and mitigate environmental impacts from operational activities on the biodiversity values identified throughout the Project area, by implementing appropriate and practical mitigation and management measures. These measures will be implemented during each of the various Project stages including prior to construction, during construction, during operations, and at project decommissioning.

For each identified biodiversity value, management measures were developed to ensure that:

- impacts to conservation significant species or communities are avoided where possible;
- there is no significant impact to identified conservation significant species and communities relevant to the EPBC Act;
- there is no significant residual impact to relevant matters under the Environmental Offsets Act 2020.

The overall objectives of this BMP is to:

- describe practical measures to avoid, minimize and mitigate impacts of the Project on the identified biodiversity values;
- describe monitoring measures that will be implemented to assess the effectiveness of the management measures, and inform adaptive management actions;
- provide a streamlined process to ensure the management and monitoring actions can be implemented for each project stage;
- ensure reporting can demonstrate ongoing management and monitoring has been implemented, to address project compliance, and where necessary identify potential areas for improvement.

The BMP applies to all CCO employees, external contractors and any other personnel involved in day-to-day activities across the Project, particularly during the construction and operational phases.

2.1 Relationship to other plans

CCO have developed and will implement several other management plans across Project that will interact with this BMP. The management measures outlined in this BMP are consistent with these other management plans, which have been listed in **Table 1**. The successful implementation of these plans will support the BMP and help to ensure that biodiversity values within the Project are protected.

Table 1 Related management plans

Document	Comments
Species Management Program (SMP): Broadmeadow East Coal Mine (Approved 30/3/2022)	The Project has an approved high-risk SMP which is a requirement under the NC Act, for tampering with protected animal breeding place in Queensland. This SMP authorizes impacts to breeding places for animals protected under the NC Act; and has specific management actions for the Squatter Pigeon. Management measures outlined in this SMP have been incorporated into the development of this BMP.
Protected Plant Impact Management Plan – *Cerbera dumicola*	CCO have developed an Impact Management Plan (IMP) for *Cerbera dumicola* as part of a Protected Plant Clearing Permit Application. It contains management measures to protect remaining *C. dumicola* population and habitat for the species in the Project area.
Weed and Pest Management Plan	RPM has developed a comprehensive Weed and Pest Management plan to be implemented across the Project.
Environment Management System (EMS)	The purpose of the EMS Manual is to define the way in which environmental obligations should be managed. The manual is the key to the management plans and supporting tools and includes a noise and vibration monitoring plan, and an air quality management plan, which will be used to minimize impacts to certain biodiversity values.

3 Project Description

The Project is located approximately 35 km north of Moranbah and 120 km south-west of Mackay in the northern portion of the Bowen Basin, QLD. The Project is located on Mining Lease (ML) 70257 which is located entirely within Lot and Plan (13SP178466). Two separate easements pass through this mining lease (BGV277 and AGV151).

The Project, authorised under the Environmental Authority (EA) EA0002465, permits CCO to extract an estimated 33 million tons of high-quality metallurgical coal over an estimated 13 years. The project will employ open cut methods and it is intended to mine in a southerly direction. The ROM coal will be transported off-site for processing and then taken to a port facility via utilising existing infrastructure. The proposed components of the mine currently include:

- Mine Industrial Area (MIA);
- Mine Affected Water (MAW) dam;
- Run of Mine (ROM) coal stockpile;
- One open pit;
- Two Waste Rock Dumps (WRD);

- One topsoil stockpile;
- Flood protection diversion/levees; and
- Diversion channels and associated clean and dirty water dams.

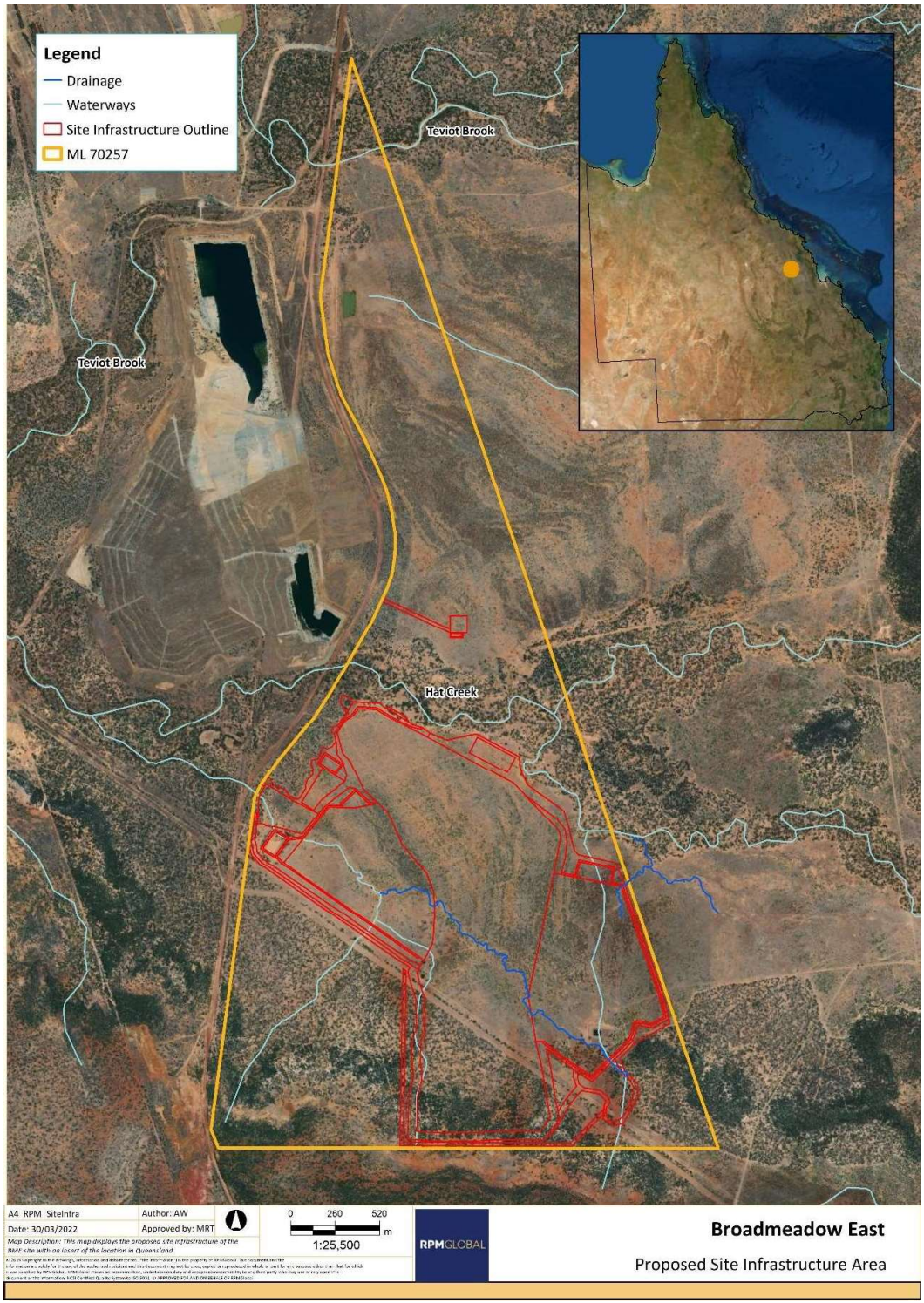
The total disturbance footprint is approximately 404 ha, which was calculated as part of the Projects recent EA amendment and used the ABC mapping method under the Model Mining Conditions. The Projects infrastructure and disturbance footprint has been provided in **Figure 1**.

3.1 Project Setting

Located in the Brigalow Belt bioregion, the ML is dominated by sparse open vegetation communities, which have been historically cleared and predominantly utilized for cattle grazing. Despite the history of disturbance, there are several patches of remnant and regrowth vegetation remaining, including an undisturbed area towards the south of the Project and the riparian corridors associated with Hat Creek and Teviot Brook.

Hat Creek and several associated tributaries run in a westerly and north-westerly direction through the mining lease, connecting with Teviot Brook and eventually the Isaac River. Teviot Brook itself only passes through the northernmost tip of the mining lease. Both watercourses are ephemeral in nature.

Figure 1 Broadmeadow East Location and Disturbance Footprint



4 Terms and Abbreviations

The terms and abbreviations listed in **Table 2** have been used throughout this management plan.

Table 2 Terms and Abbreviations

Abbreviation	Definition
BCC	Bowen Coking Coal
BMP	Biodiversity Management Plan
CCO	Coking Coal One
DAWE	Department of Agriculture, Water and the Environment
EMP	Environmental Monitoring Plan
EO Act	*Environmental Offsets Act* 2014
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999 (Cwth)*
FIR	Fauna Incident Register
FSC	Fauna Spotter Catcher
GBO	General Biosecurity Obligation
IMP	Impact Management Plan
MLES	Matters of Local Environmental Significance
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
NC Act	*Nature Conservation Act 1992*
PCSMR	Post Clearing Species Management Report
RE	Regional Ecosystem
TEC	Threatened Ecological Community
VM Act	*Vegetation Management Act 1999*
WPMP	Weed and Pest Management Plan

5 Legislation, Guidelines and Environmental Obligations

This BMP addresses Condition A3 of the Project's EA outlined in

Table 3 below. This condition states that the Project is not authorised to have a significant residual impact on any Matters of National Environmental Significance (MNES), Matters of State Environmental Significance (MSES), or a Matters of Local Environmental Significance (MLES).

Given that there are no MLES identified in the Isaac Regional Council Plan, which are relevant to the Project, this BMP will focus on MNES and MSES that may occur within the Project area.

Table 3 Environmental Authority (EA0002465) Condition to be assessed by the plan

Condition Number	Condition
A3	Significant residual impacts[1] to prescribed environmental matters[1] are not authorised under this environmental authority or the Environmental Offsets Act 2014.

[1] Definitions for "Significant residual impacts" and "Prescribed Environmental Matters" have been provided below.

Significant residual impacts are defined in the Environmental Offsets Act 2014 (EO Act) as an adverse impact, whether direct or indirect, of a prescribed activity on all or part of a prescribed environmental matter that:

a) remains, or will or is likely to remain (whether temporarily or permanently) despite on-site mitigation measures for the prescribed activity; and
b) is, or will or is likely to be significant.

In accordance with the EO Act, a **Prescribed environmental matter** is any of the following matters prescribed under a regulation to be prescribed environmental matter:

a) a Matter of National Environmental Significance (MNES) (listed in Part 3 of the EPBC Act);
b) a Matter of State Environmental Significance (MSES) (Schedule 2 of the Environmental Offsets Regulation 2014); and
c) a Matter of Local Environmental Significance (outlined by local government authorities).

6 Roles and Responsibilities

To ensure that the objectives of this BMP are achieved, roles and responsibilities have been defined in **Table 4**.

Table 4 Roles and Responsibilities

Role	Duties / Responsibilities
BME General Manager	• Ensure all legal obligations outlined in this plan are upheld. • Allocate sufficient resources to implement these measures, ensure appropriate action is being taken, and offer support to the Environmental Manager and their department.
Environmental Manager	• Ensure all legal obligations outlined in this plan are upheld. • Ensure all site staff receive appropriate training about biodiversity values identified across the Project. • Prepare and deliver training and information packages for all BCB site staff. • Ensure all environmental monitoring activities are undertaken and appropriate records are kept.
Weed and Seed Hygiene Inspector	• Must undertake appropriate training. • Conducting Weed and Seed Hygiene inspections across the Project.
Fauna Spotter Catcher (FSC)	• Must be appropriately qualified and must operate under a valid Rehabilitation Permit/Damage Mitigation Permit issued by the Department of Environment and Science under the NC Act. • Should be present during any vegetation disturbance.
All BCB Employees	• Must comply with all procedures outlined in this, and any other, management plans developed for the Project.

Role	Duties / Responsibilities
	• Have a general duty of care to report, avoid and minimise the spread of weeds and pests throughout the Project area and broader region.

Contact details have been provided in **Table 5** for locally qualified contractors and operators that may assist with injured fauna, and biosecurity washdowns.

Table 5 Contact details for relevant local contractors and operators

Stakeholder	Contact Details
Moranbah Veterinary Clinic	Phone: (07) 4941 7001 Address: 33 Mills Avenue, Moranbah 4744
Central Highlands Wildlife Carers	Hotline: 0475 288 301
3rd Party Weed and Pest Contractor	Coalfields Pest Control, (07) 4982 7000

7 Identify Biodiversity Values

Ecological assessments were conducted across the Project area in late 2020, the results of which were summarized in the *Baseline Ecology Assessment Report* (Nitro Solutions, 2021). This report included a likelihood of occurrence assessment for all Threatened Ecological Communities (TEC), listed flora and fauna species, and conservation significant Regional Ecosystems (REs).

Profiles for relevant threatened species and TECs have been provided in **Appendix A**.

7.1 Regional Ecosystems

Field verification surveys undertaken across the Project confirmed the presence of several Regional Ecosystems (REs) which have been shown on Figure 2 and outlined below:

- RE 11.3.25 (Of Concern) – *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines;
- RE 11.5.9c/11.5.3 (No concern at present) – (11.9.5c) *Eucalyptus crebra* +/- *Corymbia intermedia* +/- *E. moluccana* +/- *C. dallachiana* woodland, (11.5.3) *Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces;
- RE 11.7.2/11.7.3 (No concern at present) – (11.7.2) Acacia spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone, (11.7.3) *Eucalyptus persistens*, *Triodia mitchellii* open woodland on stripped margins of Cainozoic lateritic duricrust;
- RE 11.7.5 (Least Concern) – Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks; and
- RE 11.9.5 (Endangered) – *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks.

7.2 Threatened Ecological Communities

The mapped patches of RE 11.9.5 were also identified as patches of Brigalow (*Acacia harpophylla dominant and co-dominant*) TEC. This vegetation community is listed as one of the 16 REs associated with the Brigalow TEC in the Approved EPBC Conservation Advice for the community. Two remnant RE 11.9.5 patches and one High Value Regrowth (HVR) patch were identified in the Project area, however none of them are located within the Project's disturbance footprint (

Figure 2). It was confirmed as part of the Baseline Ecology Assessment, that these patches all met the minimum condition thresholds to qualify as belonging to the Brigalow TEC in accordance with the Approved Conservation Advice (Nitro Solutions, 2021).

7.3 Flora and Fauna Species

7.3.1 Flora Species

During the baseline ecology assessment of the Project, numerous flora species were identified including one species of conservation significance (*Cerbera dumicola*). This species is listed as Near Threatened under the NC Act. A flora survey was undertaken in January 2022 for this species to ascertain its abundance and distribution throughout the Project area. This C. dumicola population was observed to extend beyond the Project area to the south. The results of this survey were summarized in a Flora Survey Report (RPM, 2022a) and subsequently used to develop and submit a protected plants clearing permit application.

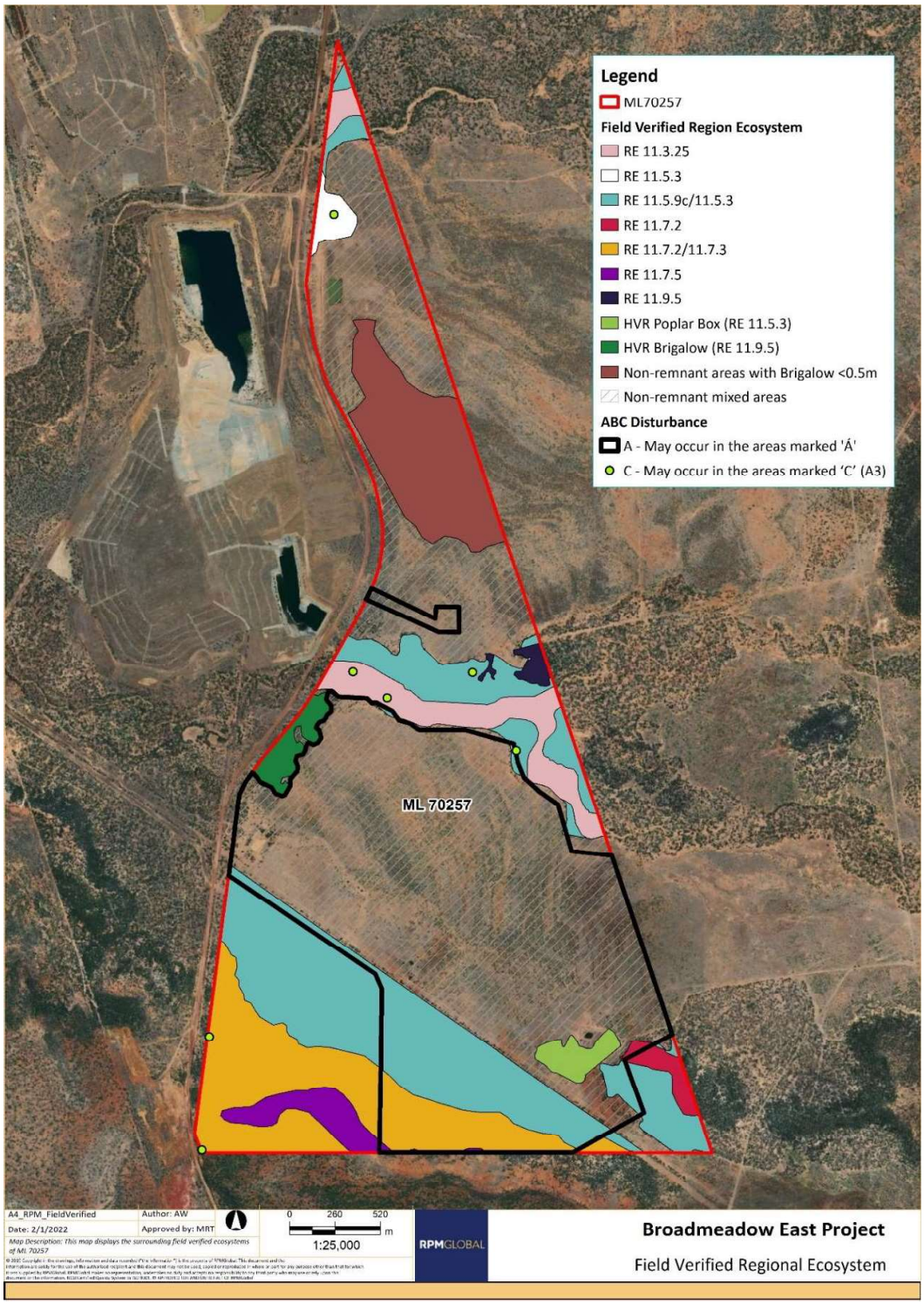
7.3.2 Fauna Species

Field surveys undertaken across the Project area identified 50 vertebrate fauna species comprising 40 birds,

6 mammals, 3 reptiles and 1 amphibian. One invertebrate (Tarantula) was also identified belonging to the Theraphosidae family which is listed as Least Concern under the NC Act. Two species of conservation significance were confirmed to be present within the Project area; the Squatter Pigeon (*Geophaps scripta scripta*) and the Rainbow Bee-eater (*Merops ornatus*), both of which are listed under the EPBC Act (Vulnerable and Migratory respectively).

In addition to the confirmed observations, suitable habitat was also identified for several other EPBC listed species including the Koala, Greater Glider and the Ornamental Snake. Despite large sections of the Project area being subject to historical clearing there are still large patches of remnant vegetation that these species could utilise for foraging and breeding. The types of habitat still present within the Project area include several man-made dams, riparian vegetation associated with Hat Creek and Teviot Brook and a large patch of mixed vegetation including open forests and dense scrubland. The remaining non-remnant areas which were previously cleared, also provide some limited foraging habitat for certain fauna species.

Figure 2 Regional Ecosystem mapping across the Project area



7.4 Invasive or Pest Species

Of all the flora species identified across the Project area, one species (*Harissa spp*.) is listed as a restricted matter under the *Biosecurity Act 2014* (Qld). Several introduced fauna species were also observed during surveys across the Project area including the European Rabbit (*Oryctolagus cuniculus*), Feral Pig (*Sus scrofa*) and the Domesticated Cow (*Box taurus*).

7.5 Summary of Biodiversity Values

Based on the information provided in the Baseline Ecology Assessment (Nitro Solutions, 2021) and subsequent Flora Survey Report (RPM, 2022a), several MNES and MSES biodiversity values have been determined for the Project area to be the basis of the plan. A summary of these values has been provided in XXXX.

Table 6 Biodiversity value known, likely to occur, or potentially occurring

Biodiversity value	Type of Matter	Details
Brigalow (*Acacia harpophylla* dominant and co-dominant) Threatened Ecological Community (TEC)	MNES	The occurrence of this TEC was verified during the Baseline Ecology Assessment and corresponds to mapped patches of remnant and high-value regrowth Regional Ecosystem (RE) 11.9.5 (**Figure** 2). This community is listed as Endangered under the EPBC Act.
Squatter Pigeon (southern) (*Geophaps scripta scripta*)	MNES, MSES	This species was observed within the Project area on two separate occasions during the 2021 Baseline Ecology Assessment (Figure 3). Suitable breeding, foraging and dispersal habitat was mapped for this species within the Project area based upon the distance from permanent water sources (i.e. farm dams) (**Figure** 4). The Squatter Pigeon is listed as Vulnerable under the EPBC Act and NC Act.
Greater Glider (*Petauroides volans*), Northern greater glider (*Petauroides volans minor*)	MNES, MSES	Whilst no greater gliders were observed during the baseline assessment, suitable habitat for this species was identified along the riparian corridors of Hat Creek and Teviot Brook which has been shown in **Figure** 5. The Greater Glider is listed as Vulnerable under the EPBC Act and NC Act (northern greater glider).
Koala (*Phascolarctos cinereus*)	MNES, MSES	Whilst no koalas were observed during the baseline assessment, several REs were identified as providing suitable habitat for this species including RE 11.5.9c/11.5.3 and 11.5.3. Suitable habitat for this species has been shown on **Figure** 5.

Biodiversity value	Type of Matter	Details
		The koala is listed as Endangered under the EPBC Act and Vulnerable under the NC Act.
Short-beaked echidna (*Tachyglossus aculeatus*)	MSES	The entire project area was determined to be suitable habitat for the species. The short-beaked echidna is listed as a Special Least Concern under the NC Act.
Ornamental Snake (*Denisonia maculata*)	MNES, MSES	Whilst no Ornamental Snakes were observed during the baseline assessment, the species has the potential to occur as several REs were identified as providing suitable habitat for this species including the riparian corridors along Hat Creek and Teviot Brook (RE 11.3.25) and the Brigalow TEC communities (RE 11.9.5). Habitat for this species has been shown in **Figure** 5 The Ornamental Snake is listed as Vulnerable under the EPBC Act and NC Act.
Rainbow Bee-eater (*Merops ornatus*)	MNES	This species was observed within the Project area on two separate occasions during the 2021 Baseline Ecology Assessment (**Figure** 3). The entire Project was identified as potential habitat for this species, and several possible burrows were identified along the riparian corridor of Hat Creek. The Rainbow Bee-eater is listed as Marine and Migratory under the EPBC Act.
RE 11.9.5 *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks	MSES	RE 11.9.5 is listed as an Endangered RE (VM Act class/Biodiversity Status) under the *Vegetation Management Act 1999* (VM Act) (**Figure** 2).
Native Frangipani *(Cerbera dumicola)* population	MSES	A large Native Frangipani population has been mapped in the southern portion of the Project area. This species was originally recorded during the Baseline Assessment and was mapped in detail during a subsequent Flora Survey (RPM, 2022a) (**Figure 6**). The native frangipani is listed as Near Threatened under the NC Act.

Figure 3 Conservation Significant Species observations across the Project area

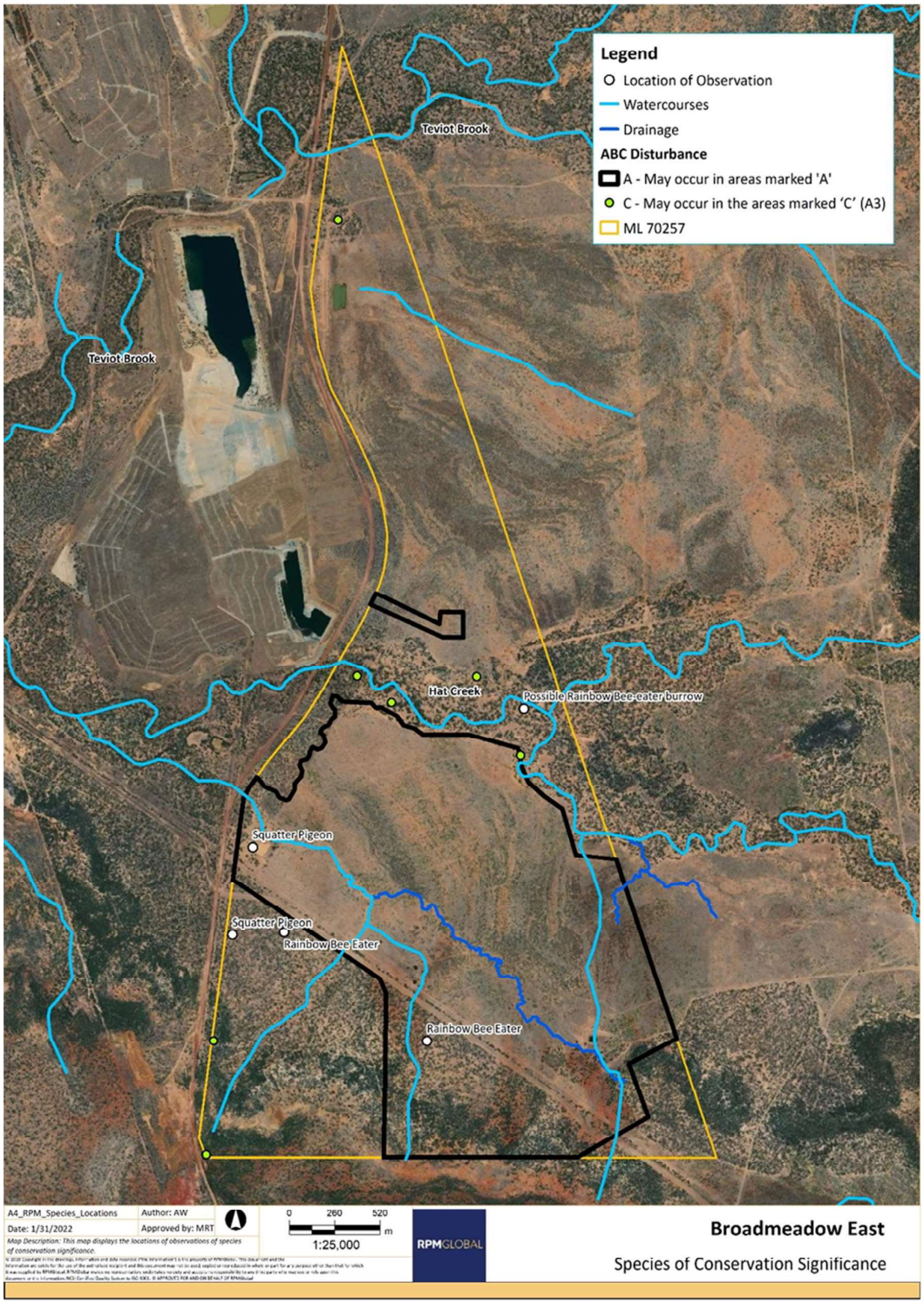


Figure 4 Potential Suitable Habitat for the Squatter Pigeon

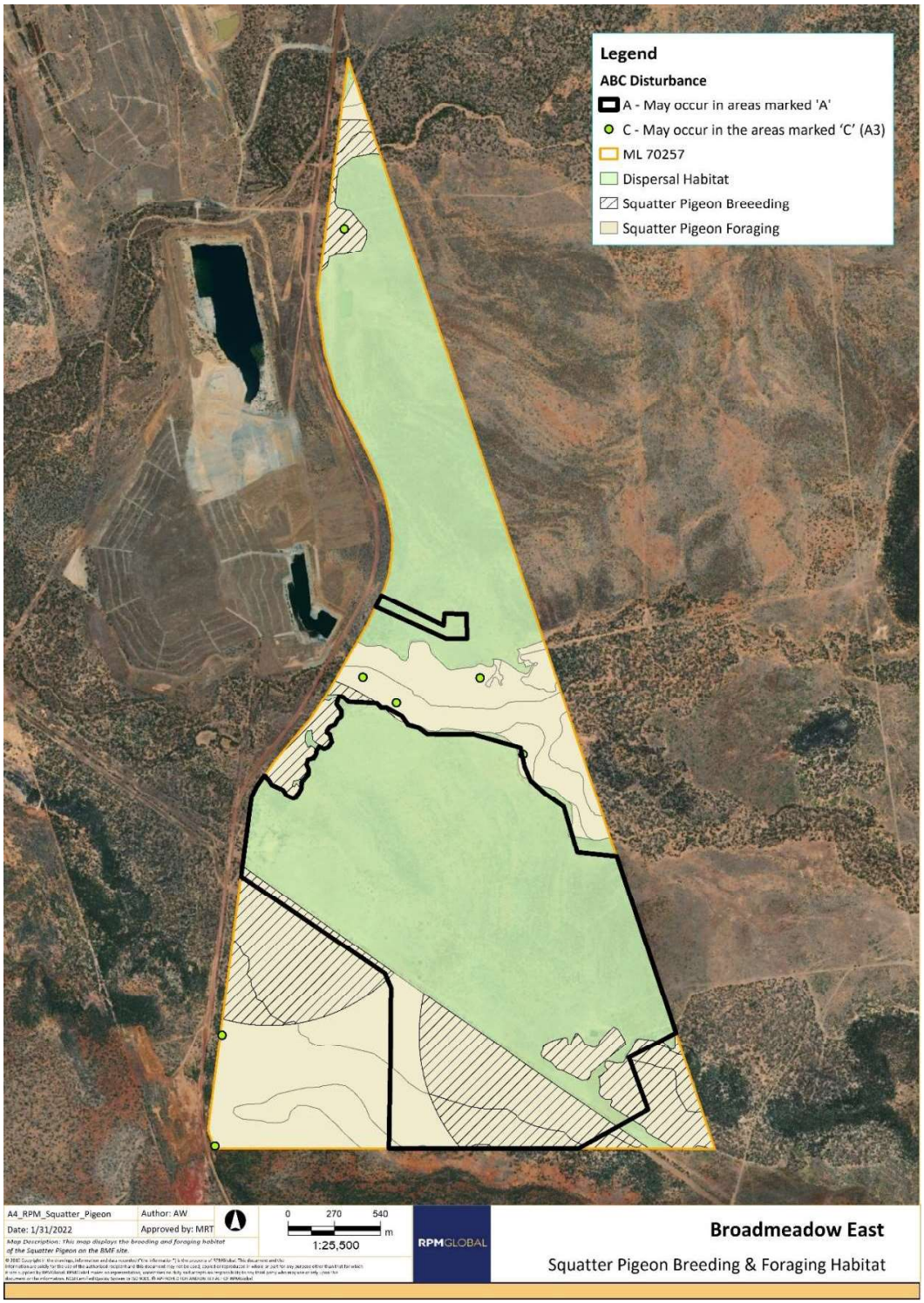


Figure 5 Suitable fauna habitat identified within the Project area

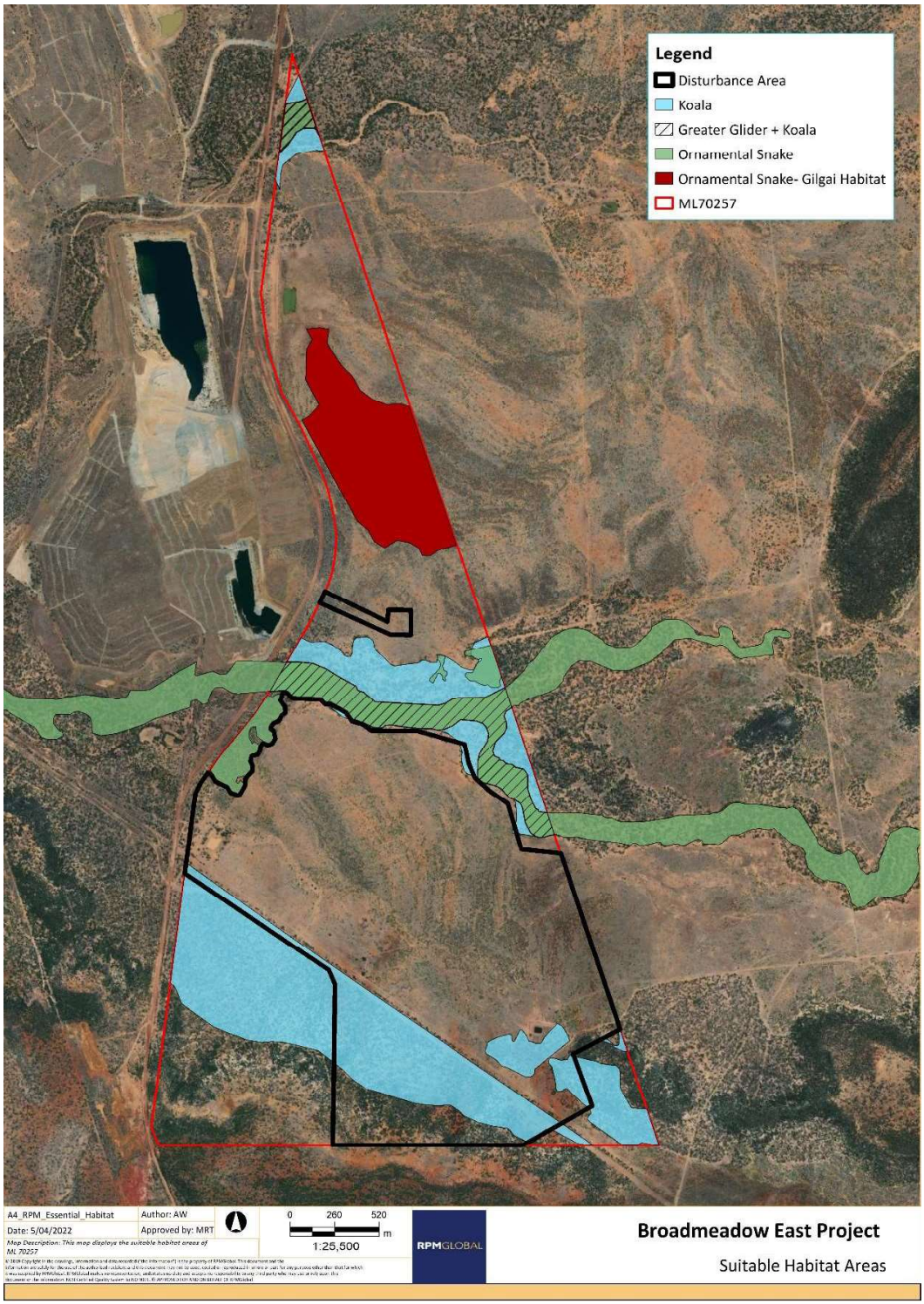
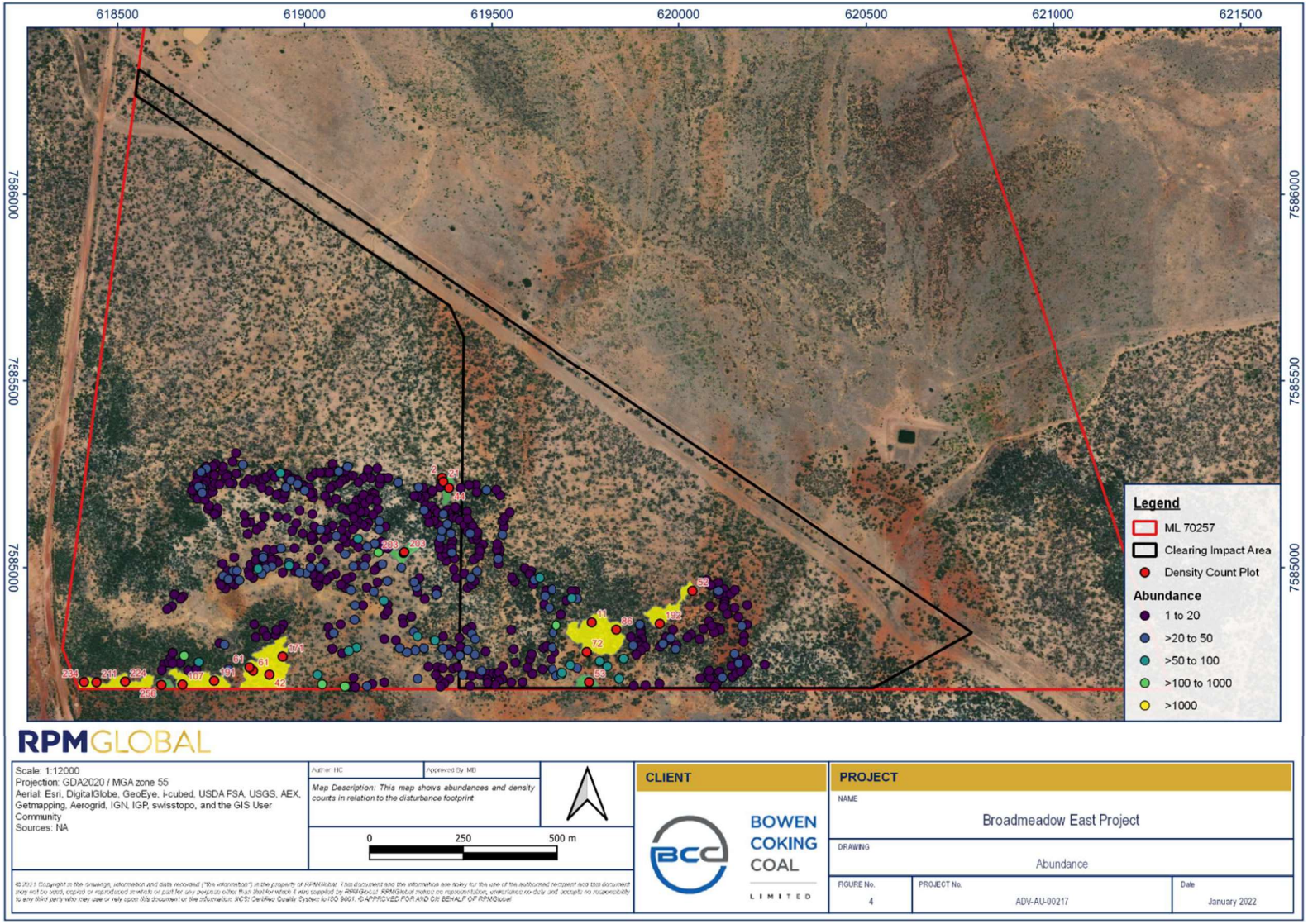


Figure 6 Distribution of Cerbera dumicola population within the Project area



8 Project Impacts

Operational activities have the potential to cause both direct and indirect impacts to these identified biodiversity values, with the level of impact depending on the type and location of the activity proposed. Potential impacts have been identified for each of these biodiversity values and have been summarised below in **Table 7**. Vegetation clearing (removal of habitat) is the main impact to each value.

Table 7 Potential impacts to significant biodiversity values

Biodiversity value	Direct Impact	Indirect Impacts	Notes
Brigalow (*Acacia harpophylla* dominant and co-dominant) Threatened Ecological Community (TEC)		✓	• Clearing of vegetation buffer adjacent to activities (pit, levee, MAW dam, ROM, MIA, access road) has potential to impact TEC leading to increase in edge effects and habitat fragmentation and/or general degradation • Retained areas may be degraded by increased bushfire intensity and frequency due to altered fuel characteristics and ignition sources around this community. • Increase in dust emissions may impact photosynthetic abilities of plants within retained TEC areas. • Loss and degradation of habitat due to changes in hydrology and soil profile. • Activities may contribute to the spread of invasive flora species (e.g. buffel grass). • Activities may contribute to increased animal disturbance (e.g. feral pigs and rabbits). • Contamination and degradation due to pollutants from chemicals and fuels.
Squatter Pigeon (southern) (*Geophaps scripta scripta*)	✓	✓	• Approximately 76.7 ha of breeding habitat and 110.4 ha of foraging habitat will be directly impacted by the Project. • Activities may contribute to fragmentation of habitat through clearing. • Activities may contribute to degradation of habitat via overgrazing or through spread of weeds (e.g. buffel grass). • Activities may increase predation by avian and terrestrial predators (including birds of prey, dingo) by reducing suitable habitat. • Activities may contribute to an increase in fauna mortality through vehicle strikes.
Greater Glider (*Petauroides volans*), Northern greater glider (*Petauroides volans minor*)		✓	• Nocturnal operational activities may contribute to light and noise pollution that could affect this species.

Biodiversity value	Direct Impact	Indirect Impacts	Notes
Koala (*Phascolarctos cinereus*)	✓	✓	• Approximately 59.8 ha of suitable habitat will be directly impacted by the Project. • Activities may contribute to fragmentation of habitat through clearing. • Activities may contribute to the spread of invasive flora species (e.g. buffel grass). • Activities may contribute to an increase in fauna mortality through vehicle strikes. • Nocturnal operational activities may contribute to light and noise pollution that could affect this species.
Short-beaked echidna (*Tachyglossus aculeatus*)	✓	✓	• Activities will reduce the abundance of terrestrial refugia utilised by this species (e.g. fallen logs, rocks and leaf litter). • Activities may contribute to an increase in fauna mortality through vehicle strikes. • Nocturnal operational activities may contribute to light and noise pollution that could affect this species.
Ornamental Snake (*Denisonia maculata*)		✓	• Activities may contribute to an increase in fauna mortality through vehicle strikes. • Activities may contribute to an increase in invasive fauna species (e.g. cane toads)
Rainbow Bee-eater (*Merops ornatus*)	✓	✓	• Activities will reduce the abundance of suitable foraging habitat for this species.
RE 11.9.5 *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks		✓	• Remnant and regrowth patches will be avoided by site layout; clearing of vegetation buffer adjacent to activities (pit, levee, MAW dam, ROM, MIA, access road has potential to impact TEC • Activities may contribute to the spread of invasive flora species (e.g. buffel grass). • Retained areas may be degraded by increased bushfire intensity and frequency due to altered fuel characteristics and ignition sources around this community. • Activities may contribute to increased animal disturbance (e.g. feral pigs and rabbits).
Native Frangipani *(Cerbera dumicola)* population	✓	✓	• Activities will disturb approximately 5,675 *C. dumicola* individuals which represents approximately 32% of the population identified within the Project area. This impact will occur across 24.2 ha of habitat for this species. • Activities may contribute to fragmentation of habitat through clearing. • Increase in dust emissions may impact photosynthetic abilities of plants within retained TEC areas. • Activities may contribute to degradation of habitat via overgrazing or through spread of weeds (e.g. buffel grass).

Based upon the Project's impacts to these biodiversity values (**Table 7**), several overarching impacts have been identified and used to develop site specific management measures (**Section 9**, **Table 8**). These overarching impacts include:

- Unnecessary vegetation and/or fauna fatalities;
- Loss of species diversity through clearing and habitat fragmentation;
- Increased risk of bushfires;
- Increase the spread of invasive flora or fauna species; and
- Degradation of neighbour and community relationships.

Other indirect impacts including noise, dust, and erosion will be managed by the Projects EMS.

9 Management Measures

Site specific management and mitigation measures for each of the overarching Project impacts have been identified for each stage of the Project and are discussed in **Table 8**. The management actions are to be implemented for the Project.

Table 8 Site Specific Management Measures

Risk	Project Phase	Management or Mitigation measure

Unnecessary vegetation and/or fauna fatalities	Clearing	• All site staff will undertake appropriate environmental inductions that will include training around the following topics:
		  ○ Familiarization with the vegetation communities and protected flora and fauna species that may be encountered on the Project;
		  ○ Brigalow TEC that is not authorised to be cleared by project activities;
		  ○ Specific familiarization with the *Cerbera dumicola* population identified within the Project area;
		  ○ Listed species and vegetation communities are protected by legislation and any unnecessary destruction or fatalities may incur penalties for the corporation and/or the individuals involved;
		  ○ Impacts to other species or vegetation communities may also incur penalties; and
		  ○ Only designated and trained personnel are allowed to handle and remove fauna.
		• A pre-clearance survey, by an appropriately qualified FSC must be undertaken prior to clearing to identify any potential breeding/roosting habitat trees or other substantial fauna habitat (i.e. ground timer, rock piles);
		• A permit to Disturb must be prepared and approved prior to any clearing activities;
		• Clearing areas must be clearly demarcated to prevent any unauthorized disturbance;
		• Site clearing works are not to be undertaken immediately after heavy rainfall;
		• Site staff must participate in daily pre-starts with their Site Supervisor to ensure that everyone is aware of the Project's clearing requirements;
		• Site staff must participate in regular Tool-Box talks on key issues relevant to current Project activities;
		• All species-specific management and mitigation measures outlined in the *C. dumicola* Impact Management Program (IMP) will be followed;
		• Prior to clearing activities, the FSC will undertake a pre-clearance survey to check for the presence of fauna species in the clearing area, and to mark any additional habitat features places to be checked;

Risk	Project Phase	Management or Mitigation measure

		• All clearing activities will be undertaken in the presence of a suitability qualified FSC;
		• Clearing activities will be undertaken in a sequential manner to ensure that any affected fauna species have sufficient time and space to vacate the area of their own volition;
		• If an animal is identified in a tree, every effort should be made to encourage the animal to leave prior to felling the tree (i.e. gently shaking tree with machine);
		• Any animals requiring care or treatment will be immediately transported to a qualified veterinarian or licensed wildlife carer;
		• CCO will maintain a Fauna Incident Register (FIR) which will contain the following information:
		  ○ Coordinates of incident;
		  ○ Clearing method and safeguards at the time of the incident;
		  ○ Qualifications of persons involved; and
		  ○ Any additional mitigation/management measures that have been put in place to reduce the likelihood of this incident occurring again.
		• If any threatened species are spotted during clearing activities, works will cease in the vicinity of the sighting until they have moved off or an appropriately FSC has been called to remove them; and
		• FSCs will keep daily records of all fauna relocations and will provide this information to the Site Supervisor upon completion of clearing activities in the form of a Post Clearing Species Management Report (PCSMR).

	Construction, Operation & Closure	• Wherever possible, once clearing activities have been completed, natural or artificial barriers should be established to ensure that operational activities are confined to the Project's disturbance footprint (i.e. soil bunds, fencing); • Animals should only be handled by an appropriately qualified FSC; • Any animal requiring care or treatment will be immediately transported to a veterinarian or licensed wildlife carer; • Records of such incidents will be taken and provided to the Site Supervisor; and • Ongoing monitoring and management measures will be conducted as per the *C. dumicola* IMP.

Risk	Project Phase	Management or Mitigation measure
	All Phases	• Vehicle speed restrictions of 60 km/h will be implemented for all sealed surfaces and 40 km/h on all unsealed surfaces; and • Given that may animals become active at dawn and dusk, as far as practicable, vehicle movements to/from site will be restricted to daylight hours.
Loss of species diversity through clearing and habitat fragmentation	Design	• The Project disturbance footprint will be designed to avoid and minimize habitat loss and fragmentation of existing vegetation wherever possible.
	Clearing, Construction	• Clearing areas must be clearly marked to prevent any unauthorized disturbance; • No clearing or disturbance should occur outside of the Project's disturbance footprint; • If an area of the Projects' disturbance footprint does not need to be cleared, it should be retained wherever possible; • Pruning of canopy trees is to be undertaken in preference to clearing wherever possible; • Pre-clearance surveys must be conducted to identify and fauna habitat features that could be salvaged or retained and used as part of rehabilitation activates post-closure. Such habitat features could include hollow trees, hollow logs, rock piles and large piles of woody debris; • Topsoil should be appropriately retained during construction activities to help facilitate rehabilitation post-closure; • Given the limited knowledge surrounding *C. dumicola* reproduction and whether seeds can remain viable in the topsoil seed bank, topsoil from the impacts populations areas will be retained separately for its use during rehabilitation of these areas; • Topsoil should be managed in accordance with the Topsoil Management Plan; and • Management actions outlined in the Sediment and Erosion Management Plan should be followed to minimize the effects of erosion.
	Closure	• Vegetation stockpiled during clearing activities will provide suitable habitat for fauna species. An appropriately qualified Fauna Spotter Catcher should be present during closure activities where these stockpiles will be disturbed; and • Rehabilitation activities should be undertaken in accordance with the Project's Progressive Rehabilitation and Closure Plan (PRCP).

Risk	Project Phase	Management or Mitigation measure
Increased risk of bushfires	Design	• All Project designs should incorporate a sufficient set back from the disturbance footprint boundary to include the construction of a firebreak to help prevent fires from jumping to surrounding vegetation; • Firebreaks should be inspected and maintained regularly to ensure that they function appropriately in accordance with the Project's Emergency Preparedness and Response Management Plan; • The Project should be designed to ensure that there is sufficient parking spaces available to avoid parking in long grass.
	Clearing, Construction, Operation & Closure	• Fire hazard warnings must be reviewed and discussed as part of daily pre-start meetings; • Fires are not permitted on site; • Given that hot works have the potential to start fires, they are only to be conducted under a Hot Work Permit, or similar, issued by the Construction Manager (or their delegate); • Adequate firefighting resources must always be available on site; and • To minimise the risk of fires, vehicles must only be parked in designated areas.
Increase the spread of invasive flora or fauna species	Design	• Washdown and laydown areas should be designed to include cane toad traps where practical. Cane toad traps can easily be constructed using designs available at: http://cart.frogwatch.org.au/index.cfm?attributes.fuseaction=shop&goto=trap
	Clearing, Construction, Operation & Closure	• All site staff will undertake appropriate environmental inductions that will include training in the following: • Familiarization with weeds and pests that could be encountered on the Project; • Familiarization with any Weed and Seed processes established by the Project in the Weed and Pest Management Plan; and • Ensure that staff are aware of the notification procedure they are required to follow if they come across a weed or pest species on site. • Under the *Biosecurity Act 2014*, all site staff must comply with their General Biosecurity Obligation (GBO) which states that everyone is obligated to take all reasonable and practical steps to minimise the risks associated with invasive plants; • Prior to delivery to site, all equipment and material are to be deemed free from pests and weeds;

Risk	Project Phase	Management or Mitigation measure
		• Weed and Seed certificates will be provided by qualified Weed and Seed Hygiene Inspectors; • Any live Cane Toads encountered on site should be euthanized humanely in accordance with the RSPCA approved methods; • To reduce the presence of feral animals or other pests, all food scraps must be placed into designated waste bins, and their lids securely closed; • No feeding of fauna on site; • The Project area will be surveyed opportunistically and on an annual basis in line with the Weed and Pest management Plan to identify and invasive species outbreaks and to focus management efforts; • Weed observations will be recorded in a Weed Register that will be continuously maintained to help prioritise Management efforts; • CCO will develop targeted management programs if particular species are frequently observed across the Project area; • Weed control activities will follow current best practice methodologies. Optimal control strategies vary for different weed species and for the size of the infestation. CCO will follow the recognized management practices outlined on the Departmental Website: https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/health-pests-weeds-diseases/weeds-diseases • Pest control activities will follow current best practice methodologies. Optimal control strategies will vary for different pest species and the type of environment they are found within. CCO will follow the recognized management practices outlined on the Departmental Website: https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/health-pests-weeds-diseases/pests/controlling/methods
Degradation of neighbour and community relationships	All Phases	• All effort will be taken to ensure that invasive weeds are contained within the Mine area and not spread to neighbouring properties. • All staff will adhere to their GBO under the Queensland Biosecurity Act 2014. • The Mine will respond to any complaints received by the Mine in relation to invasive weeds and pests.

10 Monitoring

To assess whether the project has had a significant residual impact on each of the biodiversity values, an annual compliance monitoring review checklist has been prepared (**Table 9**). As identified in **Section 8**, the principal impact to each value is vegetation clearing. Whilst completing the annual review checklist, CCO will also undertake a review if site practices to ensure that the Project will not lead to any significant residual impacts to biodiversity values.

In instances where an item on this checklist is triggered, CCO will investigate whether this has resulted in a significant residual impact.

Table 9 Annual Biodiversity Value Monitoring Checklist

Biodiversity value	Performance Criteria	Trigger	Annual Biodiversity Impact Review
Brigalow TEC No significant residual impact to Brigalow TEC. (Refer to **Figure** 2)	Area of Brigalow TEC will not be impacted by vegetation clearing.	Clearing incident in Brigalow patch	☐ No vegetation clearing outside the authorized disturbance footprint.
	No significant increase in invasive flora species within the TEC area	Increase in abundance of invasive flora species	☐ Increase in abundance of invasive flora species
	No increase in invasive pest species within the TEC area	Evidence of pest animal disturbance	☐ Evidence of pest animal disturbance
	No bushfires in TEC	Any bushfires recorded within the TEC	☐ Evidence of bushfire in TEC
Squatter Pigeon No significant residual impact to Squatter Pigeon. (Refer to **Figure** 4)	No unauthorized habitat outside the approved disturbance footprint.	Vegetation clearing outside the authorized disturbance footprint.	☐ No vegetation clearing outside the authorized disturbance footprint.
	Fauna mortality as a result of project activities	Fauna mortality through vehicle strikes, vegetation clearing activities, recorded in FIR	☐ Has a death/injury been recorded in FIR for this species?
Greater Glider, **Northern Greater Glider** No significant residual impact to Greater Glider (Refer to **Figure** 5)	No unauthorized habitat outside the approved disturbance footprint.	Vegetation clearing outside the authorized disturbance footprint.	☐ No vegetation clearing outside the authorized disturbance footprint.
	Fauna mortality as a result of project activities.	Fauna mortality recorded in FIR	☐ Has a glider death/injury been recorded in FIR?
Koala	No unauthorized habitat outside the approved disturbance footprint.	Vegetation clearing outside the authorized disturbance footprint.	☐ No vegetation clearing outside the authorized disturbance footprint.

Biodiversity value	Performance Criteria	Trigger	Annual Biodiversity Impact Review
No significant residual impact to Greater Glider. (Refer to **Figure** 5)	Fauna mortality as a result of project activities.	Fauna mortality through vehicle strike, vegetation clearing activities recorded in FIR	☐ Has a Koala death/injury been recorded in FIR?
Short-beaked echidna	Fauna mortality as a result of project activities.	Fauna mortality through vehicle strike, vegetation clearing activities recorded in FIR	☐ Has a death/injury incident been recorded in FIR for the species?
Ornamental Snake No significant residual impact to Ornamental Snake. (Refer to **Figure** 5).	No unauthorized habitat outside the approved disturbance footprint.	Vegetation clearing outside the authorized disturbance footprint.	☐ No vegetation clearing outside the authorized disturbance footprint.
	Fauna mortality as a result of project activities.	Fauna mortality recorded in FIR	☐ Has an Ornamental snake death/injury been recorded in FIR?
Rainbow Bee-eater	Fauna mortality as a result of project activities.	Fauna mortality through vehicle strike, vegetation clearing activities recorded in FIR	☐ Has a death/injury incident been recorded in FIR for the species?
Native Frangipani (Cerbera dumicola) (Refer to **Figure 6**)	No unauthorized habitat outside the approved disturbance footprint.	Vegetation clearing outside the authorized disturbance footprint.	☐ No vegetation clearing outside the authorized disturbance footprint.
	Actions identified in the Impact Management Plan.	Refer to the Impact Management Plan for monitoring and reporting actions.	
RE 11.9.5 *Acacia harpophylla* and/or Casuarina cristata open forest on fine-grained sedimentary rocks (Refer to **Figure** 2)	Area of RE will not be impacted by vegetation clearing.	Clearing incident in RE 11.9.5	☐ No vegetation clearing outside the authorized disturbance footprint.
	No significant increase in invasive flora species within the RE 11.9.5 area	Increase in abundance of invasive flora species	☐ Increase in abundance of invasive flora species
	No increase in invasive pest species within the RE 11.9.5 area	Evidence of pest animal disturbance	☐ Evidence of pest animal disturbance
	No bushfires in RE 11.9.5	Any bushfires recorded within the RE	☐ Evidence of bushfire in RE 11.9.5

11 Reporting

The effectiveness of management measures detailed throughout this BMP will be monitored through the completion of incident identification procedures, the Fauna Incident Register and completing the annual Biodiversity Value Monitoring Checklist (**Table 9**). CCO will prepare an annual report outlining the findings of these monitoring systems and the Projects overall compliance with Condition 3 of the EA (

Table 3). These reports will be provided to the administering authority upon request.

This BMP will be reviewed and updated every 3 years, to revise mitigation and management measures to reflect any changes to the conservation status of the species identified on site, or to incorporate more effective management measures. Any updates to the Project EA or amendments to the disturbance footprint will also trigger a review of this management plan.

All changes or amendments to this BMP shall be documented in an Appendix.

12 References

Department of the Environment (DoE, 2022a). Brigalow (Acacia harpophylla dominant and co-dominant) in Community and Species Profile and Threats Database, Department of the Environment, Canberra.

Department of the Environment (2022b). Geophaps scripta scripta in Species Profile and Threats Database, Department of the Environment, Canberra.

Department of the Environment (2022c). Petauroides volans in Species Profile and Threats Database, Department of the Environment, Canberra

Department of the Environment (2022d). Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) in Species Profile and Threats Database, Department of the Environment, Canberra.

Department of the Environment (2022e). Denisonia maculata in Species Profile and Threats Database, Department of the Environment, Canberra.

Nitro Solutions, 2021. Broadmeadow East Baseline Ecology Assessment.

RPM, 2022. Broadmeadow East - Flora Survey Report.

Strahan (2002) The mammals of Australia.

Triggs (2004) Track, scats and other traces: a field guide to Australian mammals.

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APPENDIX A BIODIVERSITY VALUE PROFILES

Brigalow (*Acacia harpophylla dominant and co-dominant*) Threatened Ecological Community (TEC)

Status

Brigalow TEC is listed as Endangered under the EPBC Act.

Ecology and Distribution

The listed ecological community is characterised by the presence of Brigalow (*Acacia harpophylla*) as one of the three most abundant tree species (Butler 2007). Brigalow is usually either dominant in the tree layer or co-dominant with other species such as *Casuarina cristata* (Belah), other species of Acacia, or species of Eucalyptus. Occasionally Belah, or species or Acacia or Eucalyptus may be more common than Brigalow within the broad matrix of Brigalow vegetation. The structure of the vegetation ranges from open forest to open woodland. The height of the tree layer varies from about 9 m in low rainfall areas (averaging around 500 mm per annum) to around 25 m in higher rainfall areas (averaging around 750 mm per annum) (Butler 2007). A prominent shrub layer is usually present (DoE, 2022a)



Condition Thresholds

The Brigalow TEC only includes remnant areas and areas of regrowth that retain the species composition and structural elements of its undisturbed corresponding RE. This excludes:

- Vegetation that has been comprehensively cleared (not just thinned) within the last 15 years
- Vegetation in which exotic perennial plants have more than 50% cover, assessed in a minimum area of 0.5 ha
- Patches of Brigalow that are smaller than 0.5ha.

Known Locations in the Project Area

Field surveys undertaken across the Project area identified several patches of RE 11.9.5, which is listed as one of the 16 REs associated with the Brigalow TEC in the Approved Conservation Advice. Two remnant RE 11.9.5 patches and one High Value Regrowth (HVR) patch were identified (

Figure 2). It was confirmed as part of the Baseline Ecology Assessment, that these patches all met the minimum condition thresholds needed to qualify as belonging to the Brigalow TEC in accordance with the Approved Conservation Advice (Nitro, 2021).

The mine plan was updated to avoid the Brigalow TEC. Resultantly, the Project will not have any impacts on patches of Brigalow TEC.

A significant impact assessment using the previous mine plan was undertaken for the Brigalow TEC in accordance with the Matters of National Environmental Significance: Significant Impact Guidelines Version 1.1 (DoE, 2013), as part of the Baseline Ecology Assessment. These guidelines outline seven (7) significant impact criteria for critically endangered and endangered ecological communities. The impact assessment identified that the Project would trigger one (1) of these significant impact criteria, namely: "There is a real chance or possibility that the Project will adversely affect habitat critical to the survival of the ecological community."

In accordance with the Approved Conservation Advice for this TEC, any areas that meet the diagnostic characteristics for this community are considered critical to the survival of the TEC. Given that the updated mine plan will not result in any impacts to mapped patches of RE 11.9.5, the Project will not adversely affect habitat critical to the survival of this ecological community. The proposed action will not have a significant impact upon the Brigalow Threatened Ecological Community (TEC).

Characteristics of the RE within the Project area

The patches of Brigalow TEC identified within the Project area were dominated by *Acacia harpophylla* in the canopy layer, with trees ranged in height from 12m to 15m. The shrub layer was sparse with occasional *Eremophila mitchellii* (False Sandal Wood), (*Flindersia diosperma* (Scrub Leopardwood), and *Carrisa ovata* (Currant Bush) present. Shrubs range in height from 2m to 4m.

The ground layer in these communities was also sparse and was dominated by the introduced *Cenchrus ciliaris* (Buffel Grass) and *Aristida caput-medusae* (Many Headed Wiregrass). Ground cover species range in height from 5cm to 40cm.

Threats and Impacts

The main threat to Brigalow communities has been extensive clearing for cropping and/or pasture. The impact has been further compounded by altered fire regimes and introducing exotic plant and animal species (DoE 2022a).

Currently the most important threats are those that reduce the community's extent, cause a decline in the condition of the vegetation, or impede its recover. These are mainly restricted to clearing, fire, plant and animal pests, grazing, and climate change. Additionally, fragmentation of the community can compound the impacts of weed invasion and overgrazing by native species (DoE 2022a).

Other threats are from dust, changes to hydrology and soil profiles and contaminants.

Mitigation and Management Measures

There is currently no published recovery plan for Brigalow TEC (DoE 2022a).

Squatter Pigeon (*Geophaps scripta scripta*)

Status

Vulnerable under the EPBC Act.

Ecology and Distribution

The Squatter Pigeon is a ground-dwelling pigeon that typically forages in open forests to sparse, open woodlands and scrub that are located within 3 km of a permanent or seasonal waterbody. Squatter Pigeons are largely restricted to Queensland. It is thought this species occurs as a single, contiguous (i.e. interbreeding) population (DoE 2022b). Squatter Pigeons are considered sedentary or locally nomadic, following food resources.



They nest on the ground, usually laying 2 eggs in sheltered positions, generally amongst vegetation. They prefer to nest on stony rises on sandy or gravelly soils (i.e., land zone 5 and 7) within 1km of a suitable and permanent water body (Squatter Pigeon Workshop 2011). They typically breed from April to October, although this is variable and dependent on food, primarily grass seeds (Squatter Pigeon Workshop 2011). Nests are depressions scraped into the ground beneath a tussock of grass, bush, fallen tree or log, and sparsely lined with grass. The eggs are incubated for about 17 days. Chicks remain in the next for 2-3 weeks and are dependent on their parents for about 4 weeks (DoE, 2022b).

Squatter Pigeons forage for seeds on bare ground between sparse grasses under an open canopy of trees (Squatter Pigeon Workshop 2011). They also consume legumes, herbs and forbs, acacia seeds, insects and ticks (DoE 2022b).

Habitat

According to DoE 2020b, suitable habitat for this species can generally be defined as open forests to sparse, open woodlands and scrub that are:

- Mostly dominated by Eucalypts, Corymbia, Acacia or Callitris species;
- Either remnant, regrowth or partly modified communities; and
- Located with 3 km of permanent water bodies or courses.

This species typically forages amongst patchy ground vegetation consisting of native, perennial tussock grasses and a mixture of low shrubs and forbs. Furthermore, Squatter Pigeons have been found to only breed on sandy or gravely soils that support open-forests or woodlands within 1 km of permanent water bodies (DOE 2020a).

Known Locations in the Project Area

Several squatter pigeons were observed within the Project area during the baseline ecological surveys. Several water sources are available within the Project area in the form of man-made dams. These dams have been defined as permanent water sources as they are not being fed by any external sources of water. Resultantly, the Project area can be broken up into three distinct habitat uses for this species including:

- Breeding habitat (within 1 km of permanent water);
- Foraging habitat (within 3 km of permanent water);
- Dispersal habitat (areas that individuals may move through to get to foraging or breeding habitat.

The Project area contains 166.2 ha of suitable breeding habitat, 340 ha of suitable foraging habitat and 339.8 ha of dispersal habitat that the species may utilise whilst traversing through the landscape (

Figure 4).

In accordance with the Species Profile and Threats Database (SPRAT) entry for this species, the population identified within the Project area is not considered to be an 'important population', therefore the proposed disturbance to mapped breeding, foraging and dispersal habitat is also not considered to be significant.

Threats and Impacts

The primary threats to Squatter Pigeon include overgrazing during drought, ongoing clearing of habitat, grazing of habitat by livestock and feral herbivores such as rabbits, thickening of understorey vegetation, and predation by invasive mammals such as cats and foxes (susceptibility to 'freezing' when disturbed makes them vulnerable.)

Other impacts include fragmentation of habitat, trampling of nests by domestic stock, invasion of habitat by weeds such as buffel grass, drought, bushfires. Changes in hydrological regimes can also affect the species by changing distance to water sources and feeding habitat.

Mitigation and Management Measures

The long-term survival and recovery of the Squatter Pigeon (southern) depends on (Squatter Pigeon Workshop 2011 in DoE, 2022b):

- the protection of habitat critical to the survival of the subspecies throughout its range
- the restoration of habitat which is potentially critical to the survival of the subspecies, especially in northern NSW and southern Queensland where there is a greater threat of a further contraction in the subspecies' range
- the alleviation of mortality caused by predators, particularly cats and foxes, and
- the development of a greater understanding of the subspecies' ecology and use of modified landscapes for foraging, breeding and dispersal.

Greater Glider/Northern Greater Glider (*Petauroides volans / Petauroides volans minor*)

Status

The Greater Glider and the Northern Greater Glider (subspecies) are listed as Vulnerable under the EPBC Act.

Ecology and Distribution

The Greater Glider is an arboreal nocturnal marsupial, largely restricted to eucalypt forests and woodlands with relatively old trees with an abundance of hollows, typically along watercourses.

Distribution mapping for this species and sub-species overlap in the broader region around the Project area and records from the Atlas of Living Australia indicate that the closest records for the greater glider and northern greater glider are 20 km and 5 km away respectively from the Project area.



Habitat

According to the Threatened Species Scientific Committee, suitable habitat for the species can generally be defined as eucalypt forests and woodlands and they favors forests with a diversity of eucalypt species due to seasonal variation in its preferred tree species (DoE, 2022c).

Six tree species were identified as dominant or co-dominant species to the majority of greater glider habitat. These six species each have a broad distribution throughout the geographic range of Queensland's greater glider species. In descending order of extent, these were Corymbia citriodora, Eucalyptus moluccana, E. tereticornis, E. crebra, C. intermedia and E. portuensis. Review of the literature and unpublished feeding records identifies most of these species as preferentially selected for foraging by greater gliders in Queensland. Size of trees is also important for Queensland greater gliders, with trees > 30 cm diameter at breast height (DBH) preferentially selected for foraging and > 50 cm DBH for denning. Trees > 50 cm DBH are more likely to contain suitable hollows for sheltering by greater gliders. (DoE, 2022c). Hollow bearing trees are essential for the species.

Known Locations in the Project Area

Nocturnal surveys were unable to be conducted during the baseline surveys and therefore it couldn't be confirmed whether this species is found within the Project area. They are nocturnal, do not call and remain in the tree canopy, making confirmation of their presence in the absence of nocturnal surveys difficult.

Suitable tree hollows suitable for these species were identified along the entire portion of Hat Creek found within the Project area. No scats, scratches or feeding marks were identified during the meander search undertaken along both Hat Creek and Teviot Brook.

Whilst no direct or indirect observations were made of the Greater Glider or the Northern Greater Glider within the Project area, suitable habitat for these species was identified along the riparian corridors of Hat Creek and Teviot Brook (

Figure 5).

In accordance with the Approved Conservation Advice for this species, the population that could potentially occur within the Project area is not considered to be an 'important population', therefore the proposed disturbance to mapped suitable habitat is also not considered to be significant.

Threats and Impacts

A reduction or fragmentation of suitable habitat, and removal of suitable tree hollows.

Mitigation and Management Measures

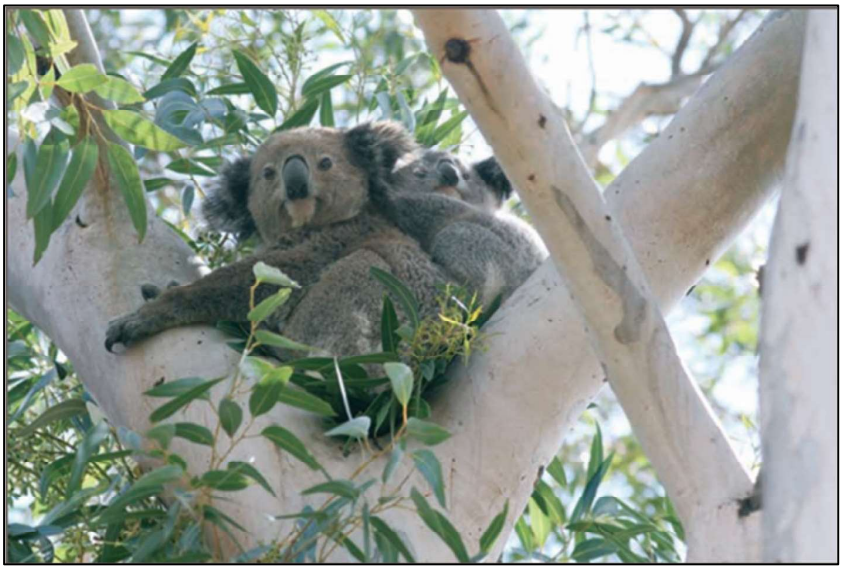
There is no recovery plan for the species (DoE 2022c.)

Koala (*Phascolarctos cinereus*)

Status

The koala is listed as Endangered under the EPBC Act 1999 (amended in 2022) and is listed as Vulnerable under the NC Act 1992.

Ecology and Distribution



The Koala is a large, grey, arboreal mammal with woolly fur. In Queensland, Koalas breed between September and April. Female koalas can breed annually, from 2 years of age. Koala joeys remain in the pouch for approximately 6 months and become independent at 12 months of age (DoE, 2022d).

The Koala feeds exclusively on eucalyptus leaves, or related genera (Corymbia, Angophora and Lophostemon). They are found in eastern Australia in fragmented populations from the temperate south to the tropical north (DoE, 2022d). The current range of the Koala in Queensland is approximately 30% of the former range.

Habitat

Koalas occur throughout temperate, sub-tropical and tropical forests, woodlands and semi-arid woodland communities that are dominated by Eucalypt species.

In Queensland, Koala populations occur in moist forests along the coast, subhumid woodlands in southern and central Queensland, and in some eucalypt woodlands along watercourse in the semi-arid environments of the western part of the state (Melzer et al. 2000in DoE, 2022d). The distribution extends inland, following drainage lines supporting River Red Gum Eucalyptus camaldulensis, although Koalas have also been found to occur in non-riverine communities in semi-arid areas.

Known Locations in the Project Area

Atlas of Living Australia records indicate that the closest available record of this species was 22 km from the Project area. Suitable habitat was identified for the Koala in the Project area, however no direct or indirect (i.e. scats and scratches) evidence was found of their presence.

Several areas of potentially suitable habitat were identified. These areas include patches of remnant RE 11.5.9c/11.5.3, remnant RE11.3.25 and HVR RE 11.5.3 (

Figure 5). These vegetation communities all contain species known to be koala food trees.

Threats and Impacts

The koala is threatened by wide-scale climate change drivers which include the increased frequency and intensity of drought and high temperatures, the increasing prevalence of weather conditions which promote bushfire, and a shrinking climatically suitable area (Adams-Hosking et al. 2011; McAlpine et al. 2015; Runge et al. 2021a). Simultaneously, koala populations are also being impacted by diseases, specifically koala retrovirus (KoRV) and Chlamydia (*Chlamydia pecorum*), human-related activities including habitat loss resulting from land clearance and mining, and mortality due to encounters with vehicles and dogs. These threats can also act synergistically. For example, habitat clearance and climate change drivers are associated with increased levels of physiological stress in wild koala populations (Narayan 2019 in DoE, 2022d). This in turn can increase the incidence and impact of localised threats arising from encounter mortality with dogs and vehicles, disease, and food shortages (Narayan 2019) in DoE, 2022d).

The primary threats are the loss and fragmentation of habitat resulting in loss of food and shelter trees, increased risk of vehicle strike and dog mortality, and isolation of populations (DoE). Habitat fragmentation results in isolated high density population areas where the risk of disease is increased and the potential to recolonize dryland areas post drought is impeded (TSSC 2012).

Threats from mining activities that may occur include vehicle strike from vehicles during earthworks and operations, noise and vibration leading to loss of usable habitat, particulate emissions may reduce habitat quality in immediate adjacent area, loss of usable habitat from light spill, degradation of habitat by weeds, entrapment in open cavities or pits, contamination of water resources by effluent and sediment, contamination of food and water by contaminants such as chemicals and fuels.

Mitigation and Management Measures

A decision has been made to have a Recovery Plan due to the 2012 recommendation by the Threatened Species Scientific Committee (TSSC 2012). This recovery plan is currently being drafted in parallel with this document (DoE, 2022d).

Mitigation and Management Measures

Mitigations identified include increasing habitat protection and strategic habitat restoration.

Short-beaked echidna (*Tachyglossus aculeatus*)

Status

The short-beaked echidna is listed as a Special Least Concern under the NC Act.

Ecology and Distribution



The Short-beaked Echidna is one of Australia's most distinctive wildlife species. It is a medium sized brownish terrestrial mammal with long spines covering the upper parts of its body, large claws and a long snout (Strahan 2002). The species occurs across the entire continent of Australia, although it is sparsely distributed in arid regions (Strahan 2002).

The Echidna is solitary, occupying a home range that overlaps with other echidnas. In arid areas, they forage at night time to avoid extreme temperatures. Elsewhere the daily activities are dictated by air temperature, with most activity as dusk and dawn in spring and autumn, midday in winter and night time in summer (Strahan 2002). Echidnas are most often encountered during the mating season in July and August, when up to ten males may follow a single female (Strahan, 2002).

The mating season is June to September. After 2 weeks of development, the female will lay a single soft shelled egg, which is incubated for approximately 10 days in the pouch (Strahan 2002). The mother will spend most of her time at the nest until the young is weaned, occasionally leaving to forage for up to several days (Strahan 2002). Females construct burrows, but the nesting site is not fixed. Burrows are located at the base of termite mounds, in soil between tree roots, and occasionally in mounds of dense vegetation (Triggs 2004). Echidna require ant and termite nests for food.

Habitat

The Echidna occur in almost all Australian environments, except intensively managed farmland, and has no specific habitat associations. It does not have any specific regional ecosystem associations. It also occurs in regrowth and cleared areas with ant and termite nests. They shelter under thick bushes and grass tussocks, in hollow logs and rocks, under piles of debris and tree roots.

Known Locations in the Project Area

Atlas of Living Australia records indicate that the closest available record of this species was 15 km from the Project area. The entire Project area was determined to be suitable habitat for this species. However, there were not sighting on during field surveys.

Threats and Impacts

Threats to populations and individuals include loss of vegetated habitat, vehicle strike, destruction of nests and predation by dogs.

Mine site activities that may impact the species includes: vehicle strike during earthworks, subsidence of habitat, entrapment in open cavities and pits, contamination of food resources by pollutants leading to mortality.

Mitigation and Management Measures

The main mitigation measures are minimizing removal of microhabitat features from remnant areas of vegetation and minimising the risk of vehicle strike during earthworks and operations.

Ornamental Snake (*Denisonia maculata*)

Status

The Ornamental Snake is listed as Vulnerable under the EPBC Act and the NC Act.

Ecology and Distribution



The Ornamental Snake is known to prefer woodlands and open forests associated with moist areas, particularly Gilgai where their preferred prey, being frogs, can be found. Known important habitat for the ornamental snake as outlined in Draft Referral guidelines for the nationally listed brigalow Belt Reptiles (DSEWPC 2011c) is limited to Gilgai depressions and mounds as well as habitat connectivity between these areas and other suitable habitats.

According to the Draft Referral guidelines for the nationally listed brigalow Belt Reptiles (DSEWPC 2011c) because population information for these species is limited, the department regards important habitat to be a surrogate for important populations. Resultantly, suitable habitat for any of the listed Brigalow Belt Reptiles is considered to be important if it is:

- Habitat where the spices has been identified during a survey;
- Near the limit of the species' known range;
- Large patches of contiguous, suitable habitat and viable landscape corridors (necessary for the purposes of breeding, dispersal or maintaining the genetic diversity of the species over successive generations); or
- A habitat type where the species is identified during a survey, but which was previously thought not to support the species.

Known Locations in the Project Area

Whilst no Ornamental Snakes were observed during the baseline assessment, the species has the potential to occur as several REs were identified as providing suitable habitat for this species including the riparian corridors along Hat Creek and Teviot Brook (RE 11.3.25) and the Brigalow TEC communities (RE 11.9.5).

Whilst no Ornamental Snakes were observed within the Project area, several patches of suitable habitat were identified within the Project area. This suitable habitat includes remnant and High Value Regrowth (HVR) RE 11.9.5, essential habitat mapped along Hat Creek (under the VM Act), and an area of non-remnant Brigalow habitat (<0.5 m in height) which contained Gilgai (

Figure 5).

Whilst an area of Gilgai habitat was identified within the Project area (Figure 1A), this area is completely disconnected from the Hat Creek corridor, and therefore does not meet the definition of 'important population' habitat. The remaining areas of suitable habitat for the ornamental snake (i.e. HVR Brigalow and RE 11.3.25 identified along the Hat Creek corridor), do however meet this definition as they form part of a contiguous corridor that extends outside the mining lease.

In accordance with the 'Draft Referral Guidelines for the nationally listed Brigalow Belt Reptiles' and the 'Species Profile and Threats Database' entry for this species, much of the suitable habitat for this species within the Project area is considered to be a surrogate for an 'important population'. With the subsequent update of the mine plan, the Project's assessment against this impact criteria has been amended to reflect no significant impact.

Threats and Impacts

The main threat to the species is continued land clearing and habitat degradation. They are potentially threatened by poisoning resulting from the ingestion of cane toads (DoE 2022e).

Mitigation and Management Measures

Mitigations and management measures for the species include control of pest species such as pigs, and minimizing impacts at known sites (DoE 2022e).

Rainbow Bee-eater (*Merops ornatus*)

Status

The rainbow bee-eater is listed as a Marine under the EPBC Act and as such, are only assessed under the EPBC Act where they occur within Commonwealth Marine Areas.

Ecology and Distribution



The Rainbow Bee-eater is medium sized, with a long slim curved bill and a long tail with distinctive tail-streamers. This species is migratory, and most of the global population breeds in Australia. It is not considered to be globally threatened. This species constructs a nest at the end of a shallow tunnel that they excavate in flat or sloping ground, typically along the banks of rivers or creeks.

The Rainbow Bee-easter rubs bees and wasps against its perch to remove their stings before eating them (Australian Museum). They also eat dragonflies, beetles, butterflies and moths.

Southern populations move north, often in huge flocks, during winter; northern populations are present year around (Australian Museum). They gather in small flocks before returning to summer breeding areas over wintering in the north. Both males and females select a suitable nesting site in a sandy bank and dig a long tunnel averaging 89.4 cm, leading to a nesting chamber, which is often lined with grasses. Both parents incubate the eggs, and both feed the young, sometimes with the assistance of helpers.

Habitat

According to DOE 2020b, this species mainly occurs in open forests, woodlands shrublands and in various cleared or semi-cleared habitats, including farmland and areas of human inhabitation, often but not necessarily near permanent water. It will use disturbed sites such as quarries, cuttings and mines to build its nesting tunnels.

The rainbow bee-eater is an aerial hunter that primarily feeds on insects collected from a multitude of different habitat types.

Known Locations in the Project Area

Whilst the Project area is not located within a Commonwealth Marine Area, individuals were observed on two separate occasions, prompting further investigation of suitable habitat for this species within the Project area.

During survey meanders along Hat Creek in particular, several potential burrows were identified, however it could not be determined which species was currently utilising them. Several other common bird species also construct nests in this way including the striated pardalote (*Pardalotus striatus*) which shares a similar distribution to the rainbow bee-eater.

Based upon the field verified mapping and the confirmation of this species presence, the entire Project area has been identified as potentially suitable habitat for this species, either for foraging or for breeding. Whilst this species will likely forage throughout each of the vegetation communities identified within the Project area, breeding and nest construction will only occur along Hat Creek or Teviot Brook, where suitable nesting sites are available.

Threats and Impacts

Undertaking activities where Rainbow Bee-eaters have nested in active mines or quarries. Introduced predators such as foxes and wild dogs can dig down into nests to eat nestlings. They are vulnerable to cane toads, and impacts to banks of creeks where they have constructed burrows.

Mitigation and Management Measures

The main mitigation for the species is minimising disturbance to the habitat.

Native Frangipani (*Cerbera dumicola*)

Status

The Native Frangipani is listed as Near Threatened under the NC Act.

Ecology and Distribution



C. dumicola is characterised as a shrub or small tree growing to 4 m in height. The species has vibrant green glossy leaves and white latex sap, making it quite distinctive. C. dumicola is known from approximately 37 populations in central coast and subcoastal Queensland, with a few populations also found in central Queensland (DES, 2022). These populations extend from 23 km south-west of Charters Towers down to Baralaba, 141 km south-west of Rockhampton and as far inland as Blackall. The species has been recorded flowering in October and is also capable of suckering.

Habitat

The species occurs across a wide range of habitats in central and southern Queensland and has known associations with the following vegetation communities (DES, 2022):

- Sandstone hills in open *E. umbra subsp. carnea*;
- On plateaus;
- In woodland of *Acacia shirleyi* with *Corymbia dolichocarpa*;

- Acidic soils in mine rehabilitation areas;
- Woodland of *A. catenulate* and *A. shirleyi* with *E. thozetiana* on a slope of sand/clay soil;
- Semi-deciduous notophyll-microphyll vine forest of *Brachychiton australis*, *Gyrocarpus americanus*, *Flindersia australis*, *Pleiogynium timorense*, *Drypetes deplanchei* and *Sterculia quadrifida* on rhyolite hillslopes;
- Open-woodland of *E. melanophloia* with occasional *Acacia shirleyi*, *E. populnea* and *E. brownie*;
- Semi-evergreen vine thicket with *Corymbia citriodora* and *Corymbia aureola emergents*;
- Woodland of *A. rhodoxylon* on brown, sandy loam; and
- *Corymbia tessellaris* and/or *Acacia aneura* open woodland.

Known Locations in the Project Area

In association with the remnant vegetation, C. dumicola was first identified within the Project area during a baseline Ecology Assessment (Nitro Solutions, 2021). Subsequently, a targeted Flora Survey for the species was conducted across the Project area in January 2022 (RPM, 2022) to support this clearing permit application. C. dumicola was found to occur in the southern portion of the ML in validated vegetation associated with several REs including:

- **RE 11.7.2/11.7.3** - Acacia spp. woodland on Cainozoic lateritic duricrust and/or Eucalyptus persistens, *Triodia mitchellii* open woodland on stripped margins of Cainozoic lateritic duricrust;
- **RE 11.7.5** - Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks; and
- **RE 11.5.9c/11.5.3** - *Eucalyptus crebra* +/- *Corymbia intermedia* +/- *E. moluccana* +/- *C. dallachiana* woodland and/or *Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces.

Most of this population was mapped within the RE 11.7.2/11.7.3 and RE 11.7.5 communities. These Acacia dominated woodlands/scrublands are known to provide suitable habitat associations for *C. dumicola*. There were also a couple of instances where the distribution of this population extended into the RE 11.5.9c/11.5.3 community.

Threats and Impacts

Threats identified for the species include vegetation clearing, weed invasion, disturbance by pest animals, wildfire and grazing.

Mitigation and Management Measures

The main mitigation for the species is minimising disturbance to the habitat.

Weed and Pest Management Plan – Broadmeadow East Mine

BOWEN COKING COAL LIMITED AND WHOLLY OWNED SUBSIDIARY COKING COAL ONE PTY LTD

VERSION 1 | August 2022



BROADMEADOW EAST PROJECT

Weed and Pest Management Plan

Client: Bowen Coking Coal Limited and wholly owned subsidary Coking Coal One Pty Ltd

Report Name: Weed and Pest Management Plan – Broadmeadow East

Job Number: ADV-AU-00217

[11/04/2022]

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Appendix A Weed and Seed TARP

1 Purpose

The purpose of this Weed and Pest Management Plan (WPMP) is to detail the requirements for the management of weeds and pests associated with the construction and operation of the Broadmeadow East Mine ("the Mine").

This document provides appropriate methodologies and guidance for the identification, assessment and management of risk pertaining to weeds and pests within the Project to ensure that:

- abundance, diversity, geographic distribution and productivity of the aquatic and terrestrial ecosystems found within the Project area is maintained;
- operational activities will not perpetuate the spread of invasive weeds and pests;
- the General Biosecurity Obligation (GBO) under the *Queensland Biosecurity Act 2014* is upheld, and all practical measures to minimize the risks associated with invasive plants are taken;
- only land within approved clearing boundaries is disturbed, to avoid unnecessary disturbance; and
- land is progressively rehabilitated to ensure that invasive species do not become established.

2 Scope

The scope of this Management Plan includes the following:

- This WPMP provides a management framework for the implementation, monitoring and review of actions aimed at reducing the spread and controlling existing weed and pest populations throughout the Project area.
- This WPMP is applicable to Bowen Coking Coal (BCB) employees, external contractors and all personnel associated with the construction and operation of the Project.

3 Overview

The Broadmeadow East Mine is located approximately 35 km North of the Township of Moranbah and 120 km south-west of Mackay in the northern portion of the Bowen Basin, QLD. The Project area is dominated by sparse open vegetation communities, which have been historically cleared and predominantly utilized as pastoral Land. Despite this history of disturbance, there are still several patches of remnant and regrowth vegetation remaining within the Project area including an undisturbed area towards the south of the Project and the riparian corridors associated with Hat Creek and Teviot Brook.

4 Terms and Abbreviations

Term or Abbreviation	Definition
BCC	Bowen Coking Coal
BMEM	Broadmeadow East Mine (the "Mine" or "Project")
GBO	General Biosecurity Obligation
Weeds and Pest	An alien species (within the meaning of the Queensland Biodiversity Convention); but is not capable of: i. Infesting humans, animals or plants; or ii. Acting as a vector for a disease; or iii. Causing diseases in any other way.
SQP	Suitability Qualified Person - a person who has the necessary qualifications, permits, training, skills and capability to carry out the task
WoNS	Weeds of National Significance
WPMP	Weed and Pest Management Plan

5 Legislation, Guidelines and Environmental Obligations

Invasive weeds and pests are some of the most serious threats to Australia's natural environment and primary industries, and as such, they are regulated under various Federal, State and Regional legislation. In addition to legislation, there are also several recognized lists and accompanying non-statutory plans and strategies for the management of weeds of national interest. For example, Weeds of National Significance (WoNS) is a framework endorsed by the Federal, State and Territory governments which identifies 32 important weed species of concern, along with applicable management practices to control their spread.

This management plan has been prepared to address requirements outlined in the following strategies, plans and legislation:

Federal

Australia's Biodiversity Conservation Strategy 2010 – 2030

Australian Weed Strategy 2017 – 2027

State

Land Protection (Pest and Stock Route Management) Act 2002

Queensland Biosecurity Act 2014

Regional

Isaac Regional Council Biosecurity Plan 2020 – 2023

Environmental Authority Conditions

There are several conditions listed in the Project's Environmental Authority (EA0002465) that include references to invasive plant and/or animal species. The management plans that address these conditions have been provided below in Table 1.

Table 1: Weed and Pest EA Conditions

Condition	Requirement	Management Plan
E13	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	Addressed in the Waste Management Plan
G27	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; 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.	Addressed in the Rehabilitation Management Plan/PRCP

6 Responsibilities

Role	Duties / Responsibilities
BMEM General Manager	Ensure all legal obligations outlined in this plan are upheld. Ensure cleared areas are progressively rehabilitated as they become available. Allocate resources to implement it, ensure appropriate action is being taken, and offer support to the Environmental Department.
Environmental Superintendent	Ensure all legal obligations outlined in this plan are upheld. Provide information to site personnel regarding Weed and Pest identification. Prepare training and information packages for all BME employees. Ensure the development and review of the Weed and Pest Management plan. Ensure Weed and Seed inspections are carried out when required. Inspect, issue and file Weed and Seed certificates when required. Communication of the Weed and Pest Management Plan to all BME employees.
Weed and Seed Hygiene Inspector	Weed and Seed Hygiene Inspectors will be responsible for all Weed and Seed Inspections on site. Utilising the Biosecurity Qld Checklists 2013. Inspectors must undertake appropriate training.
Suitably qualified person/s engaged to bait or use of firearm	Collect or handle 1080 baits. Use firearms to control pests. Provide regular reports to Environmental Manager on progress of control efforts.
Waste Contractor	Perform scheduled collections of waste receptacles that are known attractants to fauna/pests.
All BMEM employees	Duty of care to report, avoid and minimize the spread of weeds and pests throughout the Mine area and broader region. Identify when a Weed and Seed certificate may be required. Abide by Weed and Pest Management Plan. All BME personnel have a General Biosecurity Obligation.

7 Key Stakeholders and contact Details

Stakeholder	Contact Details
3rd party Weed contractor	Must be licensed (poison) for the type of pest targeted and suitably qualified, supply this document as part of the contractor's scope.
3rd party Pest contractor	Must be licensed (poison) for the type of pest targeted and suitably qualified, supply this document as part of the contractor's scope.
Isaac Regional Council	1300 472 227

8 Weed and Pest Management

8.1 Existing Environment – Baseline Surveys

Baseline surveys conducted across the Mine area, outlined in the *Baseline Ecology Assessment Report* (RPM, 2021), confirmed the presence of several weeds and pests which have been outlined below in **Table 2**. This assessment also identified several additional weeds as potentially occurring across the Mine area based upon a review of available desktop information. These additional species have been outlined in **Table 3**.

Table 2: Weeds and Pests confirmed to be present within the Mine area

Common Name	Scientific Name	Classification Under Qld Biosecurity Act 2014	Weed of National Significance Status
Harrisia cactus	*Harrisia martini*	Restricted	No
Velvety Tree Pear	*Opuntia tomentosa*	Restricted	Yes
European Rabbit	*Oryctolagus cunicules*	n/a	n/a
Feral Pig	*Sus scrofa*	n/a	n/a

Table 3: Potentially occurring weed and pest species (not limited to)

Common Name	Scientific Name	Classification Under Qld Biosecurity Act 2014	Weed of National Significance Status
Red-head Cottonbush	*Asclepias curassavica*	-	-
Wild Aster	*Symphyotrichum subulatum*	-	-
Blue Billygoat Weed	*Ageratum houstonianum*	-	-
Noogoora Burr	*Xanthium occidentale*	Other	-
Lilac Tasselflower	*Emilia sonchifolia*	-	-

Common Name	Scientific Name	Classification Under Qld Biosecurity Act 2014	Weed of National Significance Status
Bipinnate Beggar's Ticks	*Bidens bipinnata*	-	-
Parthenium Weed	*Parthenium hysterophorus*	Restricted	Yes
Common Prickly Pear	*Opuntia stricta*	Restricted	Yes
Butterfly Pea	*Clitoria ternatea*	-	-
Cow Pea	*Macroptilium lathyroides var. semierectum*	-	-
Spiny Sida	*Sida spinosa*	-	-
Flannel Weed	*Sida cordifolia*	-	-
Paddy's Lucerne	*Sida rhombifolia*	-	-
Scoparia	*Scoparia dulcis*	-	-

8.2 Risks to the Mine

The potential impacts resulting from poor management of weeds and pests may include:

- Loss of native species diversity;
- Degradation to remaining remnant and regrowth vegetation within the Mine area;
- Competition with livestock and native animals for pasture and food;
- Increase in surface erosion (see Erosion and Sediment Control Management Plan);
- Possible livestock losses; and
- Damage to neighbour relationships.

8.3 Mitigation and Management Measures

8.3.1 Loss of native species diversity due to weed or pest presence

The Mine area will be formerly surveyed on an annual to detect the presence of any weed outbreaks. Weed observations will be recorded in a Weed Register that will be continuously maintained to help prioritize management efforts. Outside of these regular survey windows, opportunistic weed observations can be made by all site staff and reported to the Environmental Superintendent, who will be responsible for managing the Weed Register.

8.3.2 Degradation of remaining remnant and regrowth vegetation within the Mine area

a) Under the *Biosecurity Act 2014*, all site staff must adhere to the GBO which states that everyone is obligated to take all reasonable and practical steps to minimize the risks associated with invasive plants.

b) Prior to any disturbance, the area in question should be inspected for the presence of invasive weeds that could be spread by operational activities. If such species are detected, appropriate containment/mitigation measures should be implemented to ensure that these weeds are not spread throughout the Mine area.

c) Heavy machinery being mobilized and demobilized to site shall be clean and free of soil material. Weed and Seed certificates will be provided if necessary.

d) All Weed and Seed certificates will be provided by qualified Weed and Seed Hygiene Inspectors.

e) To minimize disturbance and prevent unintended impacts, no machinery or vehicles is to travel off designated roads and tracks.

f) Cleared areas will be progressively rehabilitated as they become available.

g) Weed control activities will follow current best practice methodologies. Optimal control strategies vary for different weed species and for the size of the infestation. BCB will follow the recognized management practices outlined on the Departmental Website: https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/health-pests-weeds-diseases/weeds-diseases

h) Pest control activities will follow current best practice methodologies. Optimal control strategies will vary for different pest species and the type of environment they are found within. BCB will follow the recognized management practices outlined on the Departmental Website: https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/health-pests-weeds-diseases/pests/controlling/methods

8.3.3 Competition with livestock and native animals for pasture and food

a) rubbish will be contained in bins with appropriate fauna proof lids to dissuade pests;

b) any personnel collecting or handling 1080 baits will have completed the appropriate chemical product training and will be an approved user. 1080 baiting signage will be posted around relevant management areas; and

c) The removal of pests will be undertaken by a suitability qualified person. If firearms are required, personnel will ensure that they have a firearms license and comply with the various requirements under the *Weapons Act 1990*.

8.3.4 Increase in surface erosion

Refer to management actions outlined in “Erosion and Sediment Control Plan”

8.3.5 Possible livestock losses

a) any personnel collecting or handling 1080 baits will have completed the appropriate chemical product training and will be an approved user. 1080 baiting signage will be posted around relevant management areas.

b) any personnel using firearms will have a firearms license and comply with the various requirements under the *Weapons Act 1990*.

8.3.6 Damage to neighbour relationships

a) All effort will be taken to ensure that invasive weeds are contained within the Mine area and not spread to neighbouring properties.

b) All staff will adhere to the GBO under the Queensland Biosecurity Act 2014.

c) The Mine will respond to any complaints received by the Mine in relation to invasive weeds and pests.

8.4 Trigger Action Response Plans

A TARP for weeds and pests has been provided in Appendix B.

9 Records and Reporting Requirements

9.1 Record Keeping

a) Site Weed Register - opportunistic weed observations will be recorded in the Site's Weed Register, which will be used to prioritize available resources and track the implemented control strategies;

b) Site Pest Register - opportunistic pest observations will be recorded in the Site's Pest Register, which will be used to prioritize available resources and track the implemented control strategies;

c) Weed or Pest Control - weekly activity reports when weed and or pest control activities are being implemented;

d) Trapping or hunting - records of any hunting or trapping programs will be collated in the Site Pest Register;

e) Personnel Training - education of personnel through site-wide notifications, environmental alerts, inductions, toolbox talks and newsletters shall be captured in site HR records; and

f) Valid permits and registers - for personnel collecting or handling 1080 baits or firearms shall be captured in site HR records.

9.2 Review and Modification

This Management Plan will be internally reviewed/audited every two years and on an as-needed basis.

The review will:

- Assess the performance of the plan against the requirements under the relevant conditions of the EA;
- Assess weed and pest survey results to identify any potential risk of infestations or areas of concern;
- Include actions to ensure effective management for the coming year; and
- Amend the plan to address the outcome of the review.

All changes or amendments following the review are documented in the version history on page i of this document.

9.3 External Reporting

Under the Queensland Biosecurity Act 2014, everyone is required to report the occurrence of any Prohibited or Restricted invasive plants to the department without delay. For large projects, this is typically done in the first instance then not required for subsequent observations of the same species.

BCB will be required to report any new prohibited or restricted invasive plants in accordance with the Queensland Biodiversity Act.

Reporting Biosecurity Risks are to be directed to Australia Biosecurity, the hotlines below will automatically direct you to your nearest office, they are as follows:

On your property:

Exotic Plant Pest Hotline **1800 084 881** (Plant pests and diseases, weed and bees)

Emergency Animal Disease Watch Hotline **1800 675 888** (Sick Livestock or Aquatic Animals)

If they arrive in goods, containers, or parcels

Contact the See. Secure. Report. Hotline **1800 798 636**

Biosecurity Queensland

PO Box 4701

Red Hill Rockhampton (07) 4846 2621

Department of Agriculture, Water and the Environment (Rockhampton)

Red Hill Rockhampton Qld 4701.

All records will be kept in the sites' Site Weeds Register, that includes geographical information and species.

10 References

Australian Commonwealth, 2017, Australian Weeds Strategy 2017-2027

Australian Commonwealth, 2010, Australia's Biodiversity Conservation Strategy 2010-2030.

Isaac Regional Council, 2020, Biosecurity Plan 2020-2023.

Department of Agriculture Forestry and Fisheries, 2013, Vehicle and Machinery Inspection Checklists.

BOWEN COKING COAL LIMITED



APPENDIX A
WEED AND SEED TARP

	Trigger Level Description	Triggers	Response	Resources
Level 1 **NORMAL OPERATIONS**	Ongoing management of known weeds and pests within the Project area	• Weeds populations that have been identified within the Project area require ongoing management to control. • Pest species that have been identified within the Project area require ongoing management to control. • All populations of weeds are captured spatially as is up to date.	• Management measures outlined in the Weed and Pest Management Plan implemented to control weed and pest populations identified within the Project area. • Spatial mapping files are updated regularly and current. • Scheduled weed and pest inspections	• Weed and Pest Management Plan. • Biodiversity surveys. • Weed and pest identification education to BME personnel. • 3rd party weed contractor. • 3rd party pest contractor. • Spatial mapping.
Level 2 **LOW RISK EVENT**	Increased weed or pest species with potential to outcompete native flora and fauna species.	• Identification of a new invasive weed or pest within the Project area that has not been previously recorded. • Increased numbers of known populations. • Identification of a multiple weed or pest within the Project area that has not been previously recorded. • Increased number of currently known weed or pest populations.	• Remove weed or pest if possible, using site resources and dispose of adequately. • Engage 3rd party weed or pest contractor if required. • Include new population locations in weed and pest register. • Include new population locations in spatial mapping.	• 3rd party weed contractor. • 3rd party pest contractor. • Spatial mapping.

Level 3 **MODERATE RISK EVENT**	Loss of significant flora or vulnerable fauna species	• Weed of National Significance (WOSNS) identified in Project area, • Uncontrolled, outbreak of weed or pest impacting on native flora and or fauna species.	• Environmental Department to conduct investigation. • Advise DES of WONS presence and impact to flora and or fauna species. • Engage 3rd party weed or pest contractor to remove weed or pest. • Include new population locations in weed and pest register. • Include new population locations in spatial mapping.	• 3rd party weed contractor. • 3rd party pest contractor. • Spatial mapping.
Level 4 **HIGH RISK EVENT**	Not Applicable	Not Applicable	Not Applicable	Not Applicable

ENGENY

BOWEN COKING COAL

Broadmeadow East Water Management Plan

Surface Water Management and Erosion and Sediment Control Plan

BNE00100_0016-REP-001-1-WMP

11 DECEMBER 2024

DISCLAIMER

This Report has been prepared on behalf of and for the exclusive use of Bowen Coking Coal and is subject to and issued in accordance with Bowen Coking Coal instruction to Engeny Australia Pty Ltd (Engeny). The content of this Report was based on previous information and studies supplied by Bowen Coking Coal.

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	28/11/2024	Draft Issue	Jayben Zhang	Chris Harris	Chris Harris	Samantha Breslin
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Signatures:						

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1. INTRODUCTION

Engeny Australia Pty Ltd (Engeny) have been engaged by Bowen Coking Coal to prepare this Surface Water Management Plan (SWMP) and Erosion and Sediment Control Plan (ESCP) for the Broadmeadow East Mine (BME) in accordance with the relevant Environmental Authority (EA) conditions and to support the operational phase of the site.

1.1 Purpose

This combined SWMP and ESCP have been prepared to address Schedule C: Water conditions described within EA permit EA0002465 last amended in February 2023 for the BME Mining Lease (ML) 70257. This SWMP has been prepared to address surface water and erosion and sediment control management at BME in accordance with the Department of Environment, Tourism, Science and Innovation (DETSI) Guideline - Preparation of Water Management Plans for Mining Activities (ESR/2016/3111)/ (EM324) and the principles of the Best Practice Erosion and Sediment Control (BPESC) document (IECA, 2018).

The intent of this SWMP is to examine and address issues relevant to the importation, generation, use, and management of water at the mine in order to minimise the quantity of mine-affected water and manage waters in accordance with the EA and any other relevant approvals. The water management system for the site has been developed to ensure suitable containment and supply of water demands for the site whilst minimising environmental impacts on the receiving environment. This SWMP has been developed in accordance with the management hierarchy for surface water outlined within the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP (Water and Wetland Biodiversity)) (Refer to Table 1.3).

This report covers surface water only, groundwater EA permit obligations are described within Schedule D and are addressed within the BME Groundwater Management and Monitoring Program (GMMP).

1.2 Scope

This SWMP forms a key component of the Environmental Management System (EMS) for BME. This water management plan will be reviewed and revised by site staff each calendar year and a report prepared as per the review process discussed in Section 8.

This plan is applicable to Bowen Coking Coal (BCC) employees, external contractors and all personnel associated with the construction and operation of the site.

This management plan includes the following:

- A contaminant source study.
- Site surface water balance and model.
- Onsite water quality sampling.
- A water management system.
- Saline drainage prevention and management measures.
- Acid rock drainage prevention and management measures.
- Erosion and sediment control measures.
- Maintenance of water management and erosion and sediment control infrastructure.
- Locations and descriptions of all key erosion and sediment control measures on site.
- Description of how erosion and sediment control measures adequately minimise the release of sediment to receiving waters, including:
  - An assessment of the size and relevant characteristics of all Project catchment areas.
  - An assessment of relevant properties of soils and waste materials.
  - Identification of receiving waters environmental values, water quality objectives and management intent.
  - Minimum design criteria for erosion and sediment control structures to meet the management intent of receiving waters.

1.3 Project Description

As shown in Figure 1.1, BME is located approximately 35 km North of the Township of Moranbah and 120 km south-west of Mackay in the northern portion of the Bowen Basin, Queensland. The mining area is entirely within the 947-hectare (ha) ML70257. BME is subject to EA0002465 which was updated and took effect on the 27th of November 2024.

EA0002465 authorises the mining of up to one point nine (1.9) million tonnes per annum (mtpa) of run of mine (ROM) high-quality metallurgical coal over an estimated 4-year mine life.

BME is an open cut mine that employs the truck and shovel method. BME operations consist of the following components:

- Mine Industrial Area (MIA).
- Mine Affected Water (MAW) dam.
- ROM coal stockpile.
- One open pit.
- Internal tracks.
- Out of Pit Dumps (OOPDs).
- Topsoil stockpiles; and
- Associated water management infrastructure.

ROM coal will be transported off-site for processing and railed to nearby port facilities for export.

The primary land uses in the region surrounding BME are a combination of coal mining, coal seam gas and livestock grazing. The two nearest sensitive receptors are approximately 10 km from the mining activities. The area within the ML is dominated by sparse open vegetation communities, which have been historically cleared and have been predominantly utilised as pastoral land. Despite this history of disturbance there are still several patches of remnant vegetation remaining within the site area including an undisturbed area towards the southwestern corner of the ML, and riparian vegetation associated with Hat Creek and Teviot Creek. These creeks flow in a westerly direction across the site area, ultimately connecting to tributaries of the Isaac River.

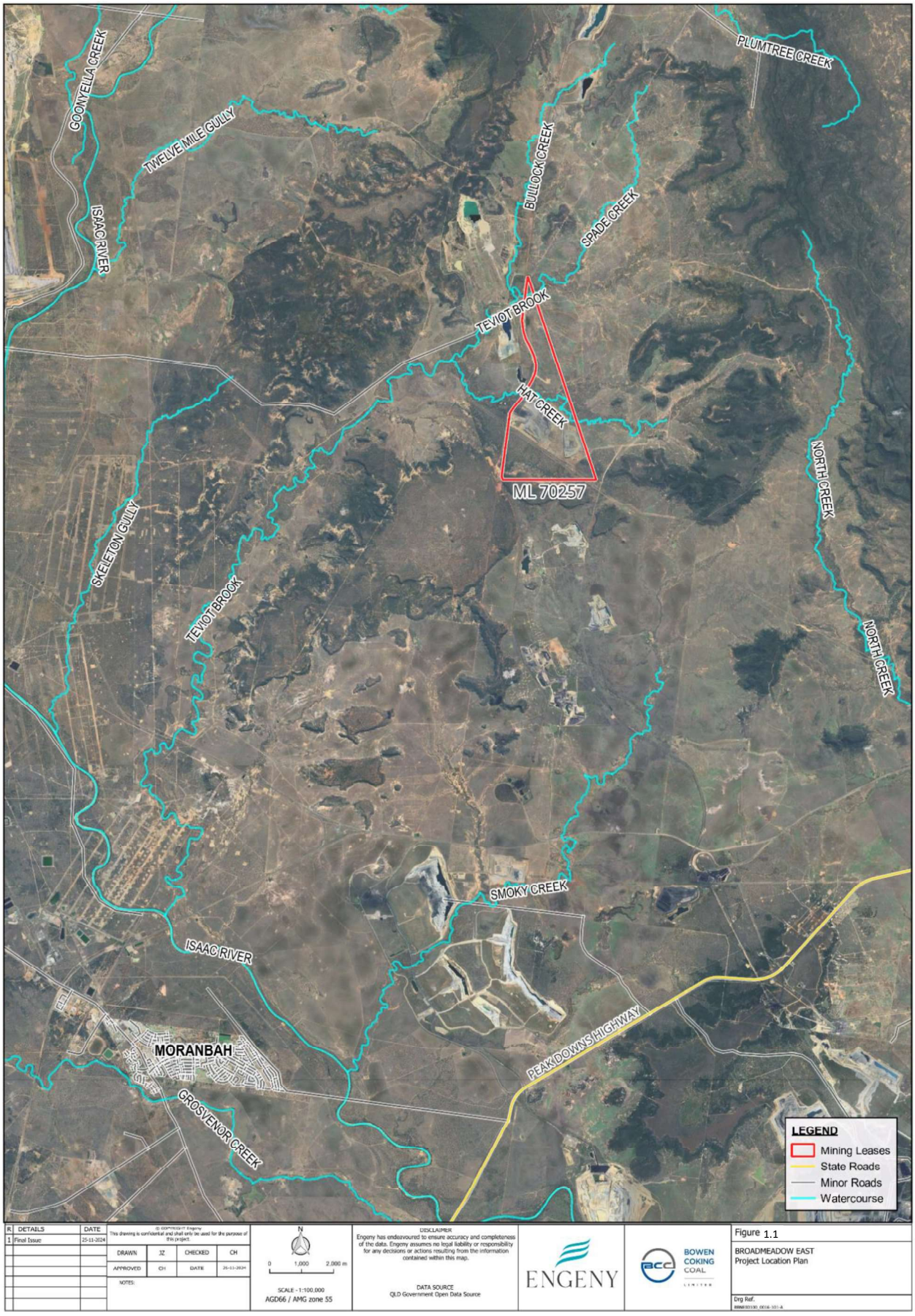


Figure 1.1: BME Project Location Plan

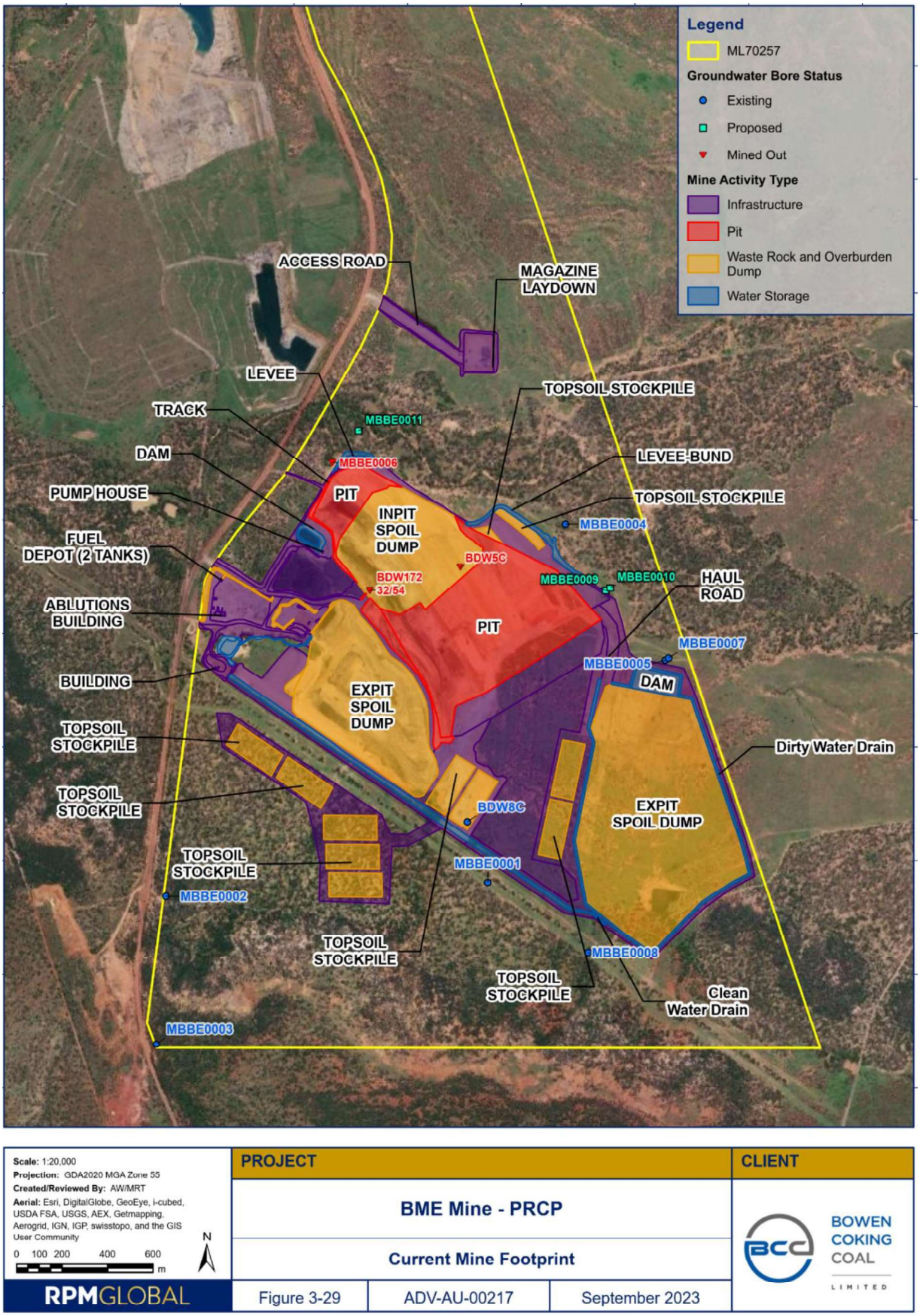


Figure 1.2: Current BME Mine Footprint Plan (Broadmeadow East Progressive Rehabilitation and Closure Plan)

1.4 Definitions and Abbreviations

TABLE 1.1: DEFINITIONS AND ABBREVIATIONS

Abbreviation	Definition
Acid Rock Drainage	The 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".
BCC	Bowen Coking Coal.
BME	Broadmeadow East Mine (the "site").
BPESC	Best Practice Erosion and Sediment Control.
CPESC	Certified Professional in Erosion and Sediment Control.
EMS	Environmental Management System.
ESC	Erosion and Sediment Control.
ESCP	Erosion and Sediment Control Plan.
EV	Environmental value.
IECA	International Erosion Control Association.
IRC	Isaac Regional Council.
MAW	Mine affected water is defined as water which has interacted with mining activities consistent with the Mine Affected Water definition from the EA. The EA states that Mine Affected Water 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.* *Associated water, coal seam gas water or produced water from the mine's petroleum activities."*
MIA	Mine Industrial Area.

Abbreviation	Definition
ML	Mining Lease.
Mtpa	Million tonnes per annum.
OOPD	Out of Pit Dump.
REMP	Receiving Environment Monitoring Program.
ROM	Run of mine.
ROWIT	Regional Operational Waste Identification Tool.
Shall	Indicates that a statement is mandatory.
Should	Indicates a recommendation.
Storm Water	Storm water is surface runoff from areas there the water quality is unaffected by mining operations. This includes runoff from undisturbed areas and areas that are classified as certified rehabilitation with stable landforms.
SWIA	Surface Water Impact Assessment.
SWD	Storm Water Dam.
Receiving waters	Hat Creek.
WaTERS	Water Tracking and Electronic Reporting System.

1.5 Legislation and Guidelines

The over-arching legislation and guidelines that apply to the management of water at BME includes:

Federal:

- Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1, Chapter 1-7.
- Online platform www.waterquality.gov.au.

State:

- *Environmental Protection Act 1994 (Qld).*
- *Environmental Protection Regulation 2019 (Qld).*
- *Mineral Resources Act 1989 (Qld).*
- *Mineral Resources Regulation 2013 (Qld).*
- *Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (Qld).*
- *Water Act 2000 (Qld).*
- Queensland Water Quality Guidelines (2009).

- Manual for Assessing Consequence Categories and Hydraulic Performance of Structures – version 5.01 (the Manual) (DEHP (now DETSI), 2016).
- DETSI Monitoring and Sampling Manual (DES, 2018).
- *Isaac River basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River), September 2011* (DEHP (now DES), 2011).
- Water Quality Guidelines for the Great Barrier Reef Marine Park (GBRMPA, 2009).

1.5.1 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) outlines that all proposed and existing mining projects must prepare and implement a SWMP for the mining project. The main object of this Act is to protect Queensland's environment while allowing for ecologically sustainable development. Under the EP Act all persons have a General Environmental Duty (GED) to not carry out any activity that causes, or is likely to cause, environmental harm unless the person has an authority to do so or has taken all reasonable and practicable measures to prevent or minimise the harm.

1.5.1.1 Environmental Authority

The Environmental Authority is issued by the administering authority (DETSI under Chapter 5 of the EP Act). EA0002465 takes effect on 27th November 2024. Table 1.2 outlines the relevant EA conditions for the site.

TABLE 1.2: RELEVANT EA SCHEDULE C (WATER) CONDITIONS

Condition		Where addressed
• C30 – Water Management Plan A Water Management Plan must be developed and implemented for the duration of the mining activities under this environmental authority.		This Management Plan
• 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 authorities guideline *Preparation of water management plans for mining activities* (ESR/2016/3111) or its successor and include:		Section 4
i)	A contaminant source study.	Section 4
ii)	Site water balance and model.	Appendix A:
iii)	Onsite water quality sampling.	Section 6
iv)	A water management system.	Section 3
v)	Saline drainage prevention and management measures.	Section 5.3.2.5
vi)	Acid rock drainage prevention and management measures.	Section 5.3.2.5
vii)	Erosion and sediment control measures.	Section 3.5

Condition	Where addressed
viii) Maintenance of water management and erosion and sediment control infrastructure; onsite sewage management system.	Section 3.7.
• C32 – The Water Management Plan required by Condition C30 must be reviewed each calendar year and a report prepared by an appropriately qualified person. 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.	Section 7
• 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.	Section 5.7
• 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.	Section 5.7
• C35 – Stormwater and water sediment controls An Erosion and Sediment Control Plan must be developed and reviewed by an appropriately qualified person for implementation 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. The plan must be made available to the administering authority within ten business days upon request.	ESCP Sections of this plan
• 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:	Sections 3, 5
• i) An assessment of the size and relevant characteristics of all catchment areas.	Section 3
• ii) An assessment of relevant properties of soils and waste materials.	Section 2.3
• iii) Identification of receiving waters environmental values, water quality objectives and management intent.	Sections 2.2, 2.5
• iv) Specification of minimum design criteria for erosion and sediment control structures to meet the management intent of receiving waters.	Section 5
• b) Detail the locations and descriptions of all erosion and sediment control measures; and	Sections 3, 5
• c) Provide an audit schedule to ensure erosion and sediment control measures are maintained.	Sections 6 and 8.3

Condition	Where addressed
	Section 7
• 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; Identify any amendments made to the Water Management Plan following the review; 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.	

1.5.2 Environmental Protection Regulation and Environmental Protection (Wetland and Water Biodiversity) Policy

The Environmental Protection Regulation (EP Regulation) 2019 further defines environmental objectives and performance outcomes for key environmental aspects. The EPP (Water and Wetland Biodiversity) is used to identify environmental values and associated water quality objectives (WQO) for Queensland's waters. The water management system strategy considers the environmental objectives and performance outcomes of the EP Regulation 2019 and incorporates the management hierarchy for surface water outlined within the EPP (Water and Wetland Biodiversity) as set out in Table 1.3.

TABLE 1.3: MANAGEMENT HIERARCHY

Management Hierarchy EPP (Water and Wetland Biodiversity)	Relevant Sections
Reduce use of water and/or production of wastewater or contaminants	Sections 3.1.1 and 3.3
Prevention of wastewater or contaminants into waters	Sections 3.1.2, 3.1.2, 3.5, 3.6 and 5.2
Recycle, re-use or treat waste waters or contaminants	Sections 3.1.2, 3.1.2, 3.5, 3.6 and 5.2
Treatment and release of waters to facilitates, land or waters	Sections 3.5, 3.6, 4, 5.3.2.4, 5.3.2.6 and 0

1.6 Responsibilities

Key responsibilities associated with the implementation of this SWMP are detailed in Table 1.4.

TABLE 1.4: RESPONSIBILITIES

Role	Duties / Responsibilities
BME General Manager	Ensure adequate resources are available to ensure water management strategies are developed, implemented, and maintained in line with all obligations and requirements stated in this plan.
Senior Environmental Advisor	Conduct audits, inspections and reviews of the site to ensure the water management strategies are being followed. Communicate and enforce the expectations of the SWMP & ESCP strategies on site. Capture and report incidents or non-compliance events.

Role	Duties / Responsibilities
All Staff, Contractors and employees at BME	Comply with the requirements of the SWMP & ESCP. Spills, incidents, complaints or non-compliances found on site are to be reported to the Environmental Manager.

1.7 Key Stakeholders

TABLE 1.5: KEY STAKEHOLDERS

Stakeholder Type	Stakeholder Name	Contact Details
Landholder	Malcom Robert Burston	-
Government Agencies / Representatives	Department of Energy and Climate (DEC)	General enquiries Phone: 13 74 68 Postal Address: GPO Box 123, BRISBANE QLD 4001
	Department of the Environment, Tourism, Science and Innovation (DETSI)	General enquiries Phone: 13 74 68 Postal address: GPO Box 2454, Brisbane, QLD 4001
	Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development (DNRMMRRD)	Phone: 13 74 68 Address: 1 William Street, Brisbane, QLD 4000
Local Councils	Isaac Regional Council (IRC)	Phone: 1300 ISAACS (1300 472 227) Email: records@isaac.qld.gov.au Postal Address: PO Box 97, MORANBAH QLD 4744
Neighbouring Mines	Peabody Burton Coal Mine (Care & Maintenance)	-
	Carborough Downs and Broadlea Mines	-
	New Lenton Burton Coal Mine (Care & Maintenance)	-
Nearby Regional Townships	Moranbah	Refer to contact details for IRC
	Coppabella	
	Nebo	
	Glenden	

2. EXISTING ENVIRONMENT

2.1 Climate

The regional climate surrounding the BME site area is classified as BSh (hot-semi arid climate), according to the Köppen-Geiger climate classification. These climates tend to have hot summers and warm to cool winters with minimal rainfall. High variability in rainfall, temperature and evaporation are common in Central Queensland.

Climate data from the SILO Data Drill at the BME site location (-21.8,148.15) was used to establish the historical rainfall data set for the BME site due to unavailability of long-term rainfall data in close proximity to the site. Rainfall and lake evaporation rates based on Silo Data Drill for the BME site are presented in Figure 2.1 and Figure 2.2.

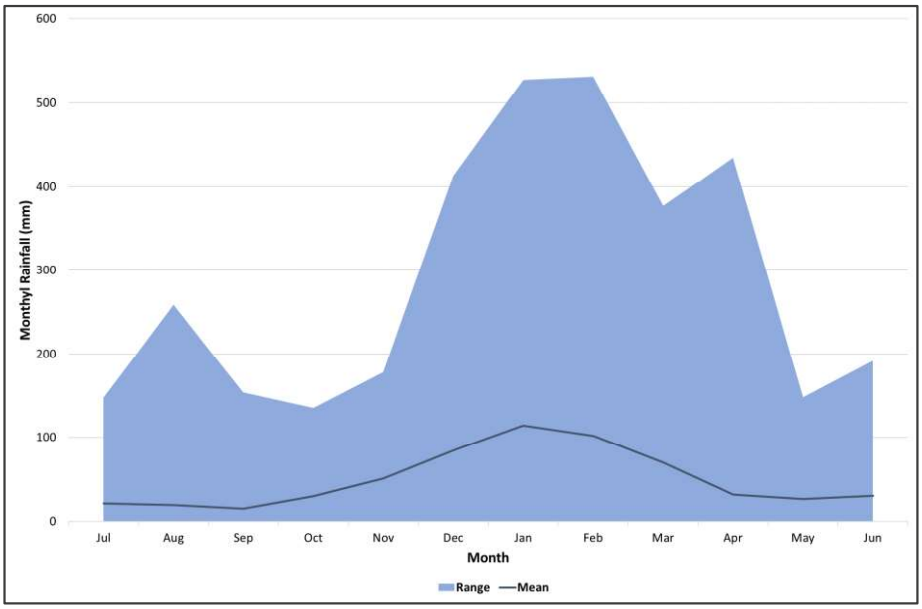


Figure 2.1: Monthly Rainfall – SILO Data Drill

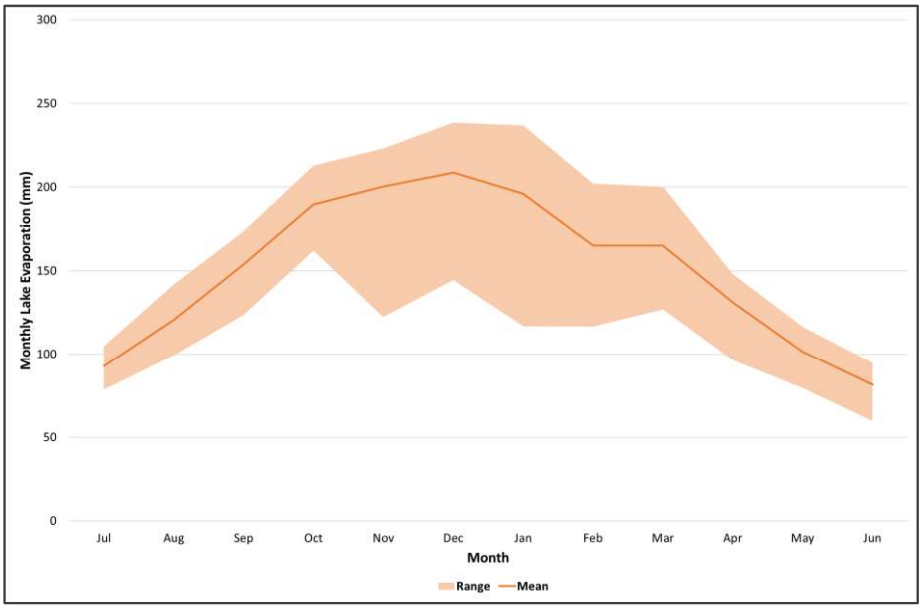


Figure 2.2: Monthly Evaporation – SILO Data Drill

Average monthly rainfall can be translated to a monthly erosion risk rating, through the application of Table 4.4.2 from the BPESC document (IECA, 2018). This risk rating can be useful when undertaking erosion and sediment control planning and design. Refer to Table 2.1 for the BME monthly erosion risk based on BOM average monthly rainfall data from the nearby weather station of Moranbah Airport (Station Number: 34035).

TABLE 2.1: AVERAGE MONTHLY EROSION RISK

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Rainfall (mm)	98.7	76.4	53.6	8.0	13.0	10.4	11.6	5.4	1.2	12.4	40.8	46.2
Erosion Risk*	M	M	M	VL	VL	VL	VL	VL	VL	VL	L	M

*Note VL – Very Low Risk , L – Low Risk , M – Medium Risk

2.2 Catchment Overview

TABLE 2.2: CATCHMENT OVERVIEW

Catchment Type	Description
Regional	The BME site is in Central Queensland within the Isaac River sub-basin (refer to Figure 2.5) which is a sub-basin of the greater Fitzroy Basin. The Fitzroy Basin has a total catchment of 142,607 km^2 with the Isaac River, Don River, Mackenzie River and Fitzroy River as the main rivers. The Fitzroy River discharges into the Coral Sea, southeast of Rockhampton.
Local - Isaac River Sub-Basin and Hat Creek Catchment	The site is located within the Isaac northern tributaries sub-catchment of the Isaac River sub-basin. Waterways that interact with the site constitute 1st and 2nd order headwaters for Hat Creek which is a Watercourse of Stream Order 3. Hat Creek flows in a westerly direction towards Teviot Brook which flows into the Isaac River approximately 26 km downstream (refer to Figure 2.4). The total catchment area for the Isaac River sub-basin is 22,363 km^2 which makes approximately 16% of the Fitzroy Basin catchment (142,607 km^2).
Existing Waterways	There are a number of named and unnamed waterways that traverse ML70257. These waterways and their Stream Orders are shown in Figure 2.3 A watercourse determination was received in June 2021 to classify the waterway features across the ML under the Water Act 2000 (DRDMW, 2021). The results are shown in Figure 2.4. The waterways within the ML are mapped as minor, non-perennial (ephemeral) waterways. All waterways are ephemeral with no observations of a reliable or consistent baseflow. **Teviot Brook** Teviot Brook is defined as a Watercourse under the *Water Act 2000* with a Stream Order of 4 and flows west across the northern end of ML 70257. However, as the majority of BME operations and infrastructure are located in the southern end of the ML, no interaction with Teviot Brook is expected as part of the site. **Hat Creek and Tributary C** Hat Creek is a 3rd order waterway defined as a Watercourse under the *Water Act 2000* (DRDMW, 2021). It flows through the center of the ML from east to west. Hat Creek confluences with Teviot Brook approximately 3.6 km downstream of the western ML boundary. Tributary C is also a determined Watercourse and flows into Hat Creek just inside of the eastern ML boundary. Due to their relatively small catchments, Hat Creek and Tributary C are likely to only sustain flow for short periods directly after rainfall events. Both Hat Creek and Tributary C have a uniform sand bed with defined channel banks greater than 1 m in height in most locations. Most of Hat Creek is bordered by a thin band of mature riparian vegetation. There are sections of Hat Creek that have existing scouring and/or eroding banks, particularly where vegetation has been cleared or is not present and dispersive soils are exposed. There is exposed bedrock at numerous locations within both Hat Creek and Tributary C but more prominent towards the eastern ML boundary. Livestock currently access both Watercourses. **Tributary A, Tributary C and Tributary D**

Catchment Type	Description
	Tributary A is an unnamed 2nd order tributary of Hat Creek that flows from the southern end of the ML in a north-western direction. Tributary A is classed as Drainage Features under the *Water Act 2000* (DRDMW, 2021). Tributary D is an unnamed 1st order Drainage Feature. Tributary D flowed directly into Teviot Brook prior to mining of the Peabody Broadmeadow West Pit and now flows into an existing embankment farm dam in the northern end of the ML. Due to their small catchments, Tributary A and D are likely to only sustain flow for very short periods directly after rainfall events. In contrast to Hat Creek, Tributary A has shallower banks with undefined channels at times. Most of their reaches have been cleared for grazing and there is limited riparian vegetation within the ML except for the most upstream sections in the south. Dispersive soils are present, and some sections of the Drainage Features had eroding banks with piping of banks. Tributary B was a 2nd order tributary of Hat Creek that was classified as a Drainage Feature under the *Water Act 2000* and previously flowed into Tributary A in the south-eastern portion of the ML. Due to progression of mining, the majority of Tributary B and its catchment have been interrupted and the majority of Tributary B no longer exists within the site.

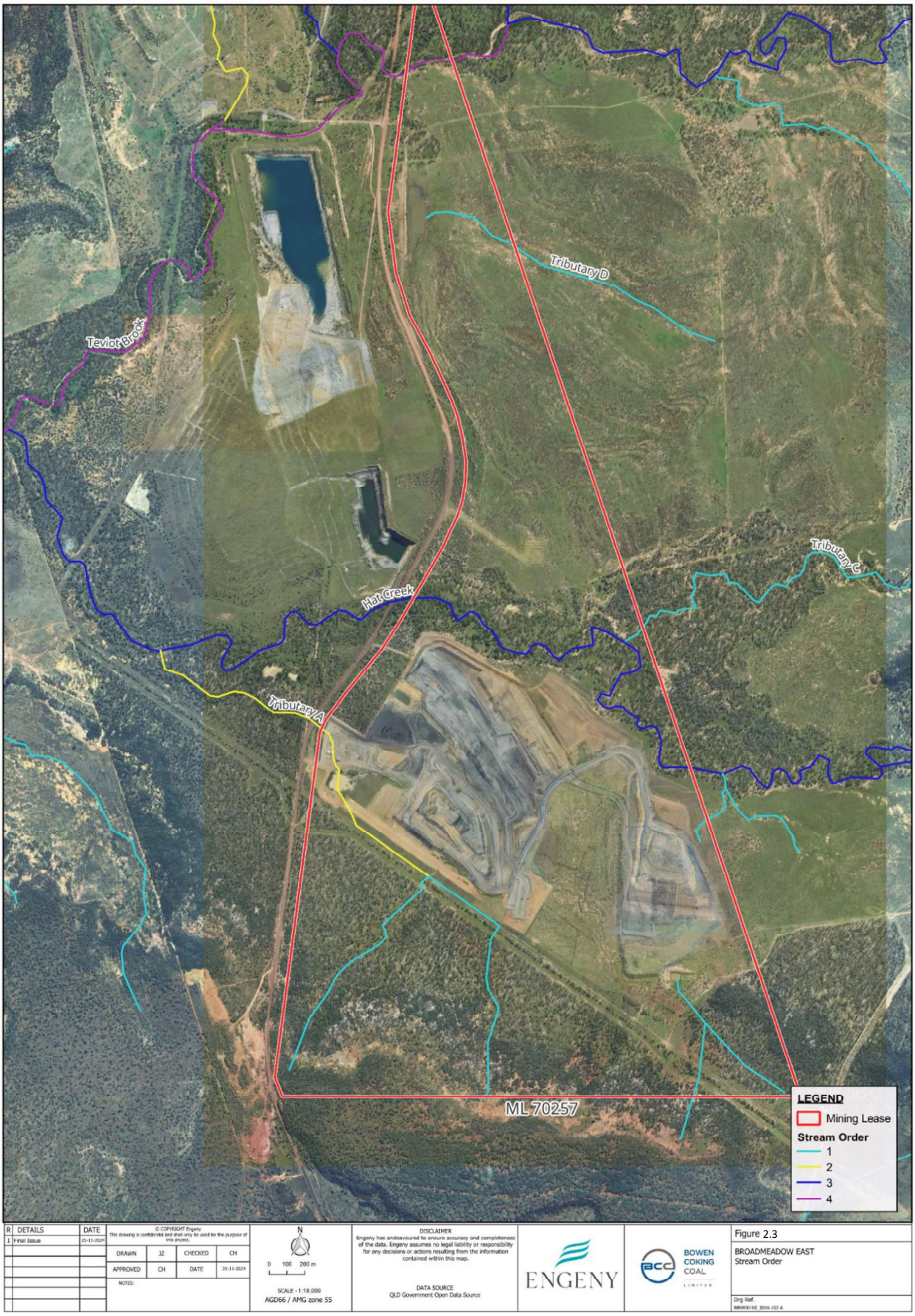


Figure 2.3: Waterway Stream Order

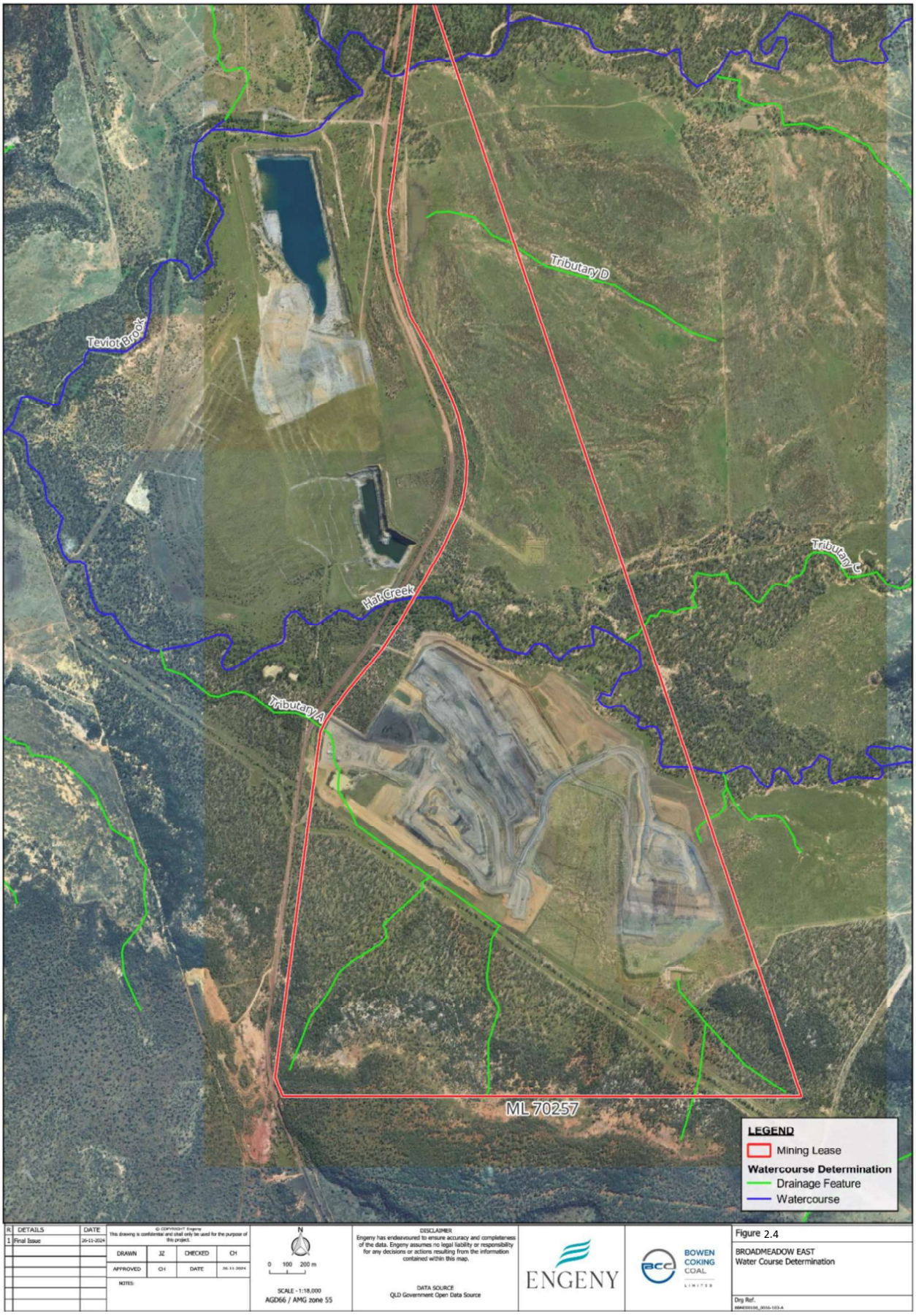


Figure 2.4: Watercourse Determination

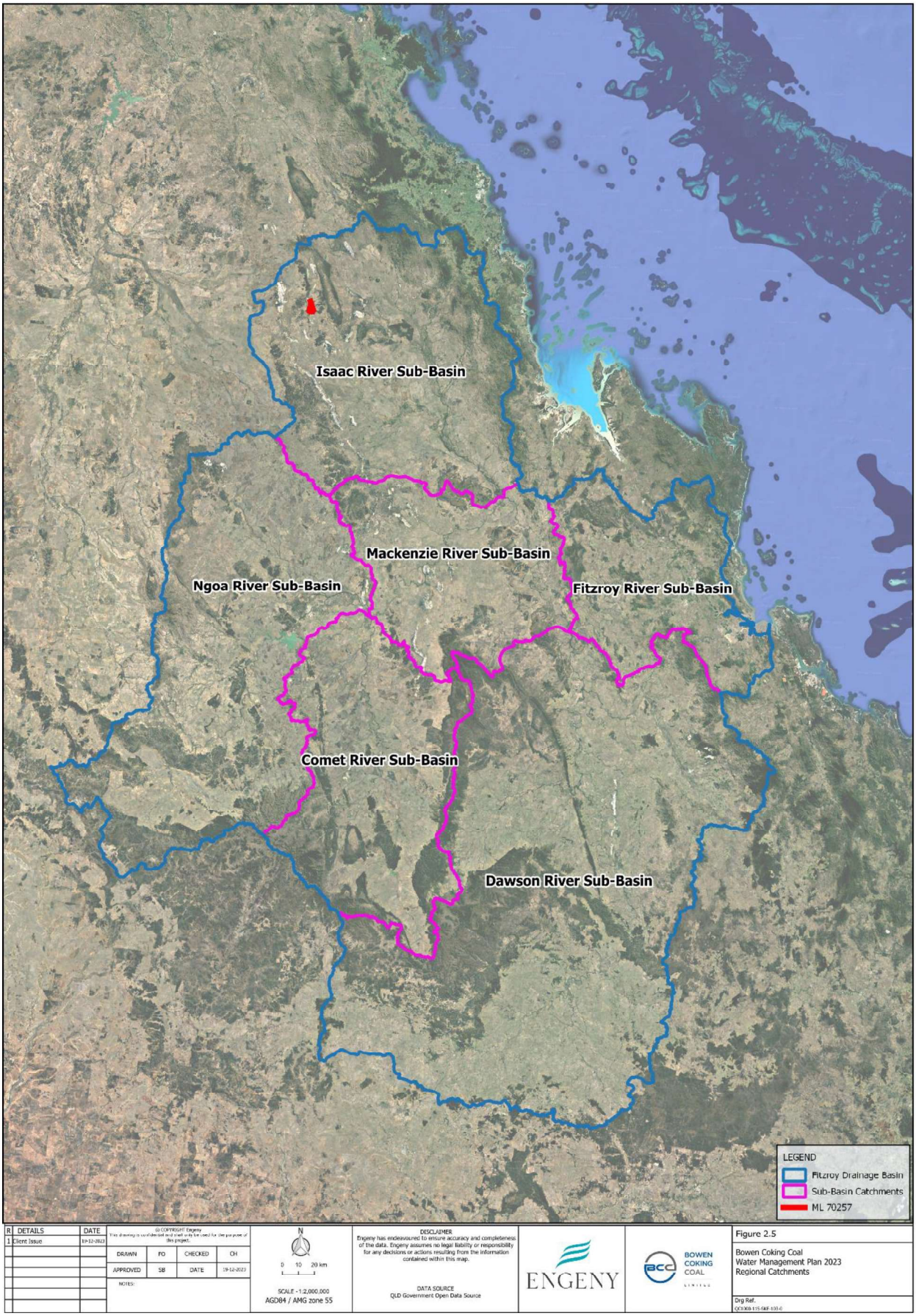


Figure 2.5: Regional Catchments – Fitzroy Basin

2.3 Soils

Soil identification mapping from SGM Environmental shows that soils within the BME site are a mixture of Chromosol, Dermosol, Kandosol and Vertosol (SGM Environmental, 2021) (Refer to Figure 2.6). Site observations indicate that dispersive soils are present on site. For example, some drainage features on site are experiencing eroding banks with some piping (Refer to Figure 2.7).

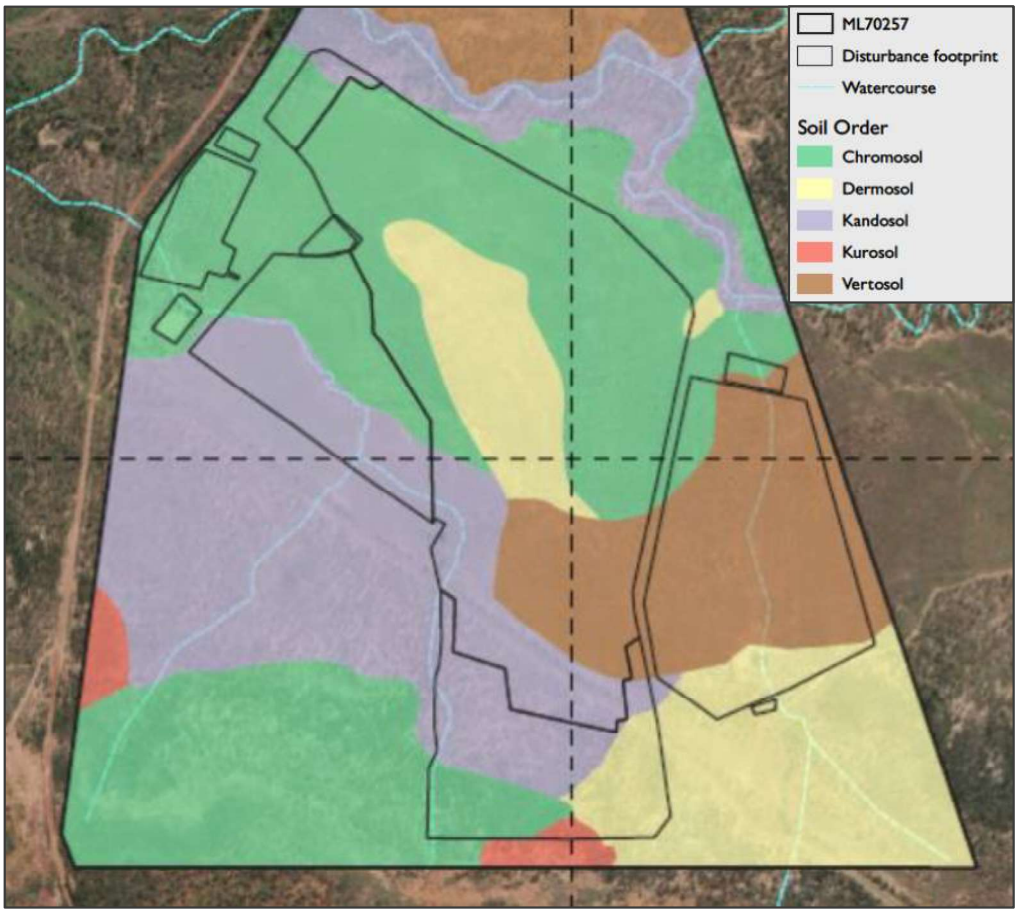


Figure 2.6: Soil Order Mapping (SGM Environmental, 2021)



Figure 2.7: Condition of Some, or Some Parts of Existing Drainage Features

2.4 Topography

The BME site is relatively flat, with a slight fall to the north-west, contour topography data of the BME site is shown in Figure 2.8. Hat Creek and Tributary A (which flows into Hat Creek) are the topographic low points nearest to the mine. Vegetation within the ML has been historically cleared for grazing except for thin bands of riparian vegetation along the creeks/tributaries. Historically there is some evidence of grazing within the creeks/tributaries.

The site currently has several key topographic feature changes from existing topographic conditions within the disturbance boundary as of November 2024, these topographic features may change in extent however no additional pits or OOPDs are proposed as part of mine planning for BME. These major topographic features are presented and labelled in Figure 2.8.

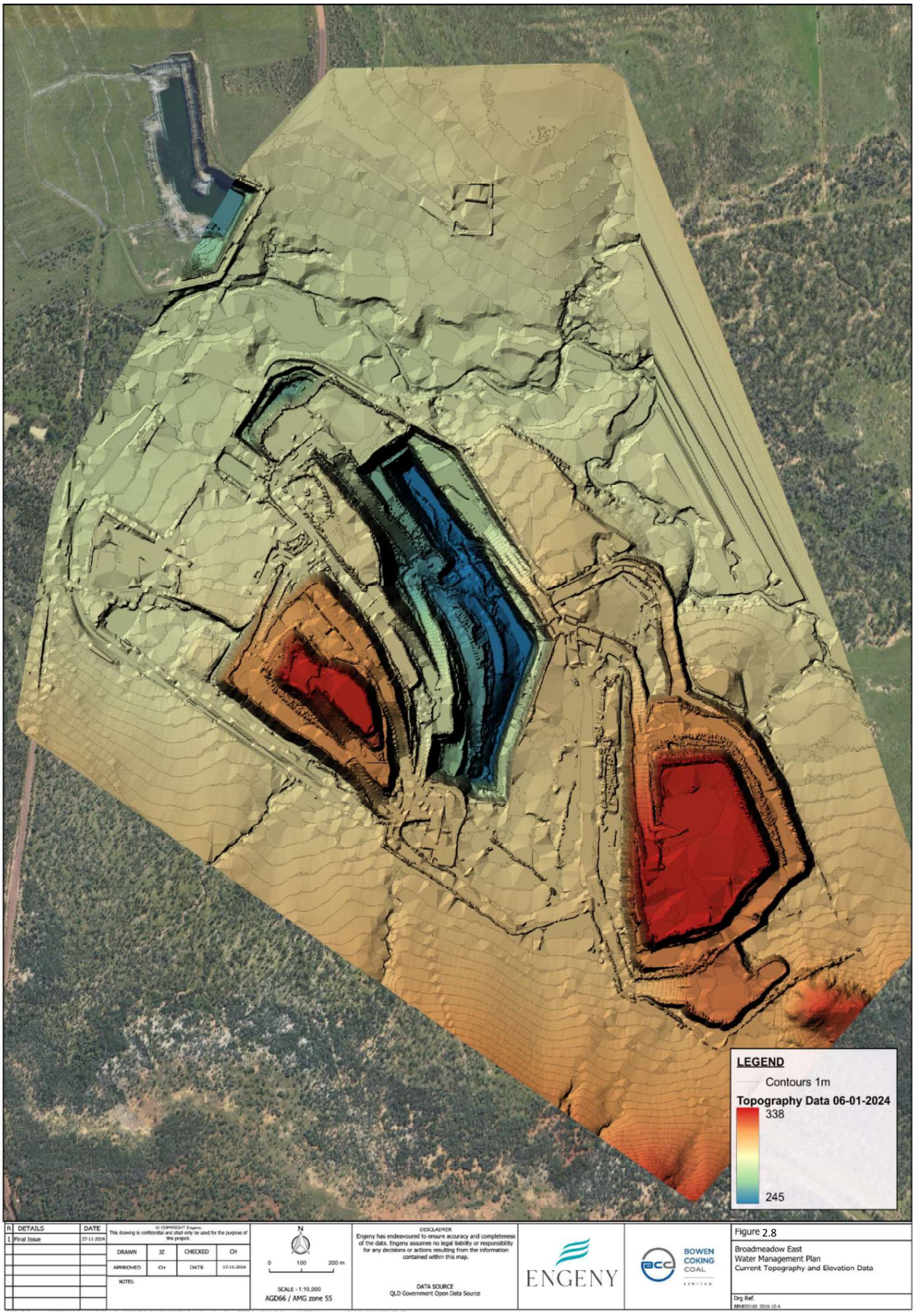


Figure 2.8: Current Topography and Elevation Data as of 2024

2.5 Environmental Values

The Environmental Values (EVs) reflect the ecological, social and economic values and uses of the waterway and are the qualities of waterways that should be protected from activities in the catchment. Protecting EVs aims to ensure healthy aquatic ecosystems and waterways that are safe and suitable for community use. The BME site is located in the Upper Isaac region of the Isaac River sub-basin. EVs for this region are defined in the *Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River sub-basin (including Connors River), September 2011* (DEHP (now DETSI), 2011). The BME site is located within an undeveloped area of the Isaac northern tributaries (refer to Figure 1.1). The EVs scheduled for the undeveloped areas within this region are:

- Aquatic ecosystems.
- Stock water.
- Human consumer.
- Primary recreation.
- Secondary recreation.
- Visual recreation.
- Drinking water, and,
- Cultural and spiritual values.

The receiving environment is not known to provide for any of the human consumer, recreational, or drinking water EVs. The Receiving Environment Monitoring Program (REMP) was completed on June 8 for 2023. The REMP further describes the relevant EVs for the receiving environment as:

- Aquatic ecosystems (slightly to moderately disturbed).
- Stock water; and,
- Cultural and spiritual values.

2.6 Water Quality

There are currently four REMP monitoring sites to collect site-specific surface quality data for the site's receiving environment. MP1 and MP2 are downstream sites which are used for impact monitoring. There is both an off-lease and on-lease site along the Hat Creek watercourse. MP3 and MP4 are upstream sites which are used as reference monitoring sites, which will assist with establishing a baseline dataset of water quality data. Like the downstream sites, there is one off-lease and on-lease along the same watercourse.

The REMP monitoring was completed during the wet season (November 2022 to March 2023) when streamflow occurred. This monitoring includes water quality monitoring which covers the parameters listed in Table 2.2. There have been no releases of mine-affected water from the site during the REMP reporting period. Two samples of surface water quality sampling data were sent for laboratory analysis following two separate flow events at Hat Creek. Physiochemical parameters were also collected in-situ over the entire duration of the wet season. After analysis of the in-situ data, there remains insufficient flow events and data to extrapolate any trends. From the laboratory analysis (undertaken as part of REMP), there have been reported isolated exceedances of WQO during the two flow events. As a result of these flow events these observations were documented that:

- Turbidity was extremely high and above specified WQOs.
- Suspended solids were two to three times above WQOs.
- Analytical concentrations of dissolved copper and aluminium exceeded WQOs.

Laboratory samples were also tested for the mine water dam (MWD) at RP1 and garnered similar results as the Hat Creek at MP1. Typical pH for the MWD ranged between 7.6 to 8.6. Electrical conductivity (EC) had a maximum observation of 153 µS/cm.

At this stage of the mine life, there is not sufficient data for a thorough analysis and determination of site-specific water quality for the BME receiving environment.

2.7 Water Quality Objectives

WQO for the receiving environment corresponding to the EVs defined in Section 2.3 are outlined within the *Isaac River basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River), September 2011* (DEHP (now DETSI), 2011) are presented in Table 2.3. As drinking water was determined to not be a relevant EV for the site, WQOs are defined for aquatic ecosystem and stock watering only.

In addition to the published WQOs, the receiving waterway contaminant limits under the EA have been presented in Table 2.3. This provides a comparison of the regional WQOs against local approved water quality contaminant limits for BME. The receiving waterway contaminant limits will be able to be reviewed and potentially refined (via EA amendment) for the site once a statistically sufficient dataset of baseline local water quality data has been obtained in accordance with Queensland Water Quality Guidelines requirements. Where the EA does not contain a receiving waterway contaminant limit for a particular parameter, the published WQO should be applied.

TABLE 2.3: WATER QUALITY OBJECTIVES

Indicator	Approved EA Receiving Waters Contaminant Trigger Level (Table C6)	EPP (Water) Water Quality Objectives	
		Aquatic Ecosystems	Stock watering
pH	6.5-8.5	6.5-8.5	-
Conductivity (Base flow)	250 µS/cm	720 µS/cm	-
Conductivity (High flow)		250 µS/cm	
Total dissolved Solids (TDS)	-	-	Cattle: 4,000 mg/L (no adverse effects) 5,000 mg/L (no loss of production)
Ammonia N	-	20 µg/L	-
Oxidised N	-	60 µg/L	-
Organic N	-	420 µg/L	-
Total Nitrogen	-	500 µg/L	-
Filterable reactive phosphorus	-	20 µg/L	-
Total Phosphorus	-	50 µg/L	-
Chlorophyll	-	5 µg/L	-
Dissolved Oxygen	-	85%-110% saturation	-
Turbidity	50 NTU	50 NTU	-
Suspended Solids	55 mg/L	55 mg/L	-

Indicator	Approved EA Receiving Waters Contaminant Trigger Level (Table C6)	EPP (Water) Water Quality Objectives	
		Aquatic Ecosystems	Stock watering
Sulphate	25 mg/L	25 mg/L	-
Nitrate	-	-	-
Sodium	-	-	-
Aluminium	-	0.055 mg/L[1]	5 mg/L
Arsenic	-	0.013 mg/L[1]	0.5-5 mg/L
Barium	-	-	-
Boron	-	0.37 mg/L[1]	5 mg/L
Cadmium	-	0.2 µg/L[1]	10 µg/L
Chromium	1 µg/L	0.001 mg/L[1]	1 mg/L
Cobalt	-	-	1,000 µg /L
Copper	2 µg/L	1.4 µg/L[1]	1,000 µg/L (cattle)
Fluoride	-	-	2 mg/L
Lead	-	3.4 µg/L[1]	100 µg/L
Manganese	-	1.9 mg/L[1]	Not sufficiently toxic
Mercury	-	-	2 µg/L
Molybdenum	-	-	150 µg/L
Nickel	-	0.011 mg/L[1]	1 mg/L
Selenium	5 µg/L	11 µg/L[1]	20 µg/L
Uranium	1 µg/L	-	200 µg/L
Zinc	8 µg/L	8 µg/L[1]	20 mg/L
Petroleum hydrocarbons (C6 - C9)	-	-	-
Petroleum hydrocarbons (C10 - C36)	-	-	-

[1] From (ANZECC & ARMCANZ, 2000)

3. SITE WATER MANAGEMENT SYSTEM

3.1 Surface Water Types and Infrastructure

3.1.1 Stormwater

Stormwater is defined as rainfall runoff from catchment area that has not come into contact with or been disturbed by BME mining operation.

The majority of the undisturbed catchment upstream of the mine footprint (in the south) is directed around the mine and western OOPD via a clean water diversion drain which directs water to the north-west (refer to Figure 1.2). The diversion of stormwater runoff from catchments upstream and around mining areas has reduced the generation of mine affected water for treatment and/or storage.

It is the intent of the ultimate surface water management strategy prior to closure (as presented in the Progressive Rehabilitation and Closure Plan (PRCP)) that additional stormwater catchment area to the south of South Pit is diverted around the mine's eastern OOPDs via additional diversion drainage that will be required later in the mine's operational life.

Clean water dam/s are proposed as required for short periods during the life of mine where incidental capture of clean water runoff behind the progressing pit highwall is unavoidable. The clean water dam/s can be used to intercept the natural catchment upstream of the mining pit highwall to prevent additional accumulation of MAW. The clean water dam/s are not to be used for water take. The intention for clean water dams is that they remain not interacted with by mining activities or other disturbed areas, captured water will then undergo in-situ field testing to ensure it meets release criteria and treatment applied (if required) before being pumped to the clean water diversion drain or a defined tributary of Hat Creek.

A summary of stormwater water infrastructure is provided in Table 3.1. Several short-term (<1 year) stormwater drains have been proposed throughout the life of mine to minimise the accumulation of runoff in operational areas.

TABLE 3.1: STORMWATER WATER KEY INFRASTRUCTURE AND STORAGES

Feature / Structure ID	Description	Catchment Area	Key Details
South Western Stormwater Drain	Diverts stormwater from catchment south of the BME area to the north-west around the mine footprint and towards the Unnamed Tributary A before entering Hat Creek.	Up to 327 ha	2.3 km drainage channel
Clean Water Dam (CWD1)	Clean water dam/s capture stormwater runoff that has not interacted with mining activities or other mining disturbed land use for a short period of time upstream of the South Pit highwall progression. CWD1 is a temporary structure/control. It is proposed the CWD1 could feasibly be continuously relocated as required to account for the progression of South Pit until the catchment can be diverted into the south clean water drain. Any runoff captured by the CWD1 will be actively dewatered into the south-western clean water drain or a new south-eastern diversion drain. Any discharges from CWD1 will undergo in-situ field testing to ensure it meets release criteria and treatment will be applied if required prior to release into receiving environment.	41 ha	3.4 ML (Sized using same basis as a Sediment Dam)

Due to the overall mining footprint and initial mining in the northern pit extent being located within the pre-mining 1 in 1000-year flood extent, a flood protection levee has been constructed around North Pit to provide 1 in 1000 year flood immunity (refer to Table 3.2).

South Pit Levee has been conservatively proposed in the mine's future for further flood protection of the operational pit however is not currently required, designed or constructed. The need for South Pit Levee will continue to be reviewed over the life of mine.

TABLE 3.2: FLOOD PROTECTION LEVEE INFRASTRUCTURE

Feature/ Structure ID	Location	Regulated Structure
North Pit Levee	North-western perimeter of North Pit	Yes
South Pit Levee	Eastern highwall of the South Pit	No (Not yet required or constructed)

3.1.2 Mine Affected Water

MAW is defined as water which has interacted with mining activities consistent with the MAW definition from the EA. The EA states that MAW:

a) means the following types of water:

vii) pit water, tailings dam water, processing plant water;
viii) 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;
ix) 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;
x) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated;
xi) groundwater from the mine's dewatering activities;
xii) a mix of mine affected water (under any of paragraphs i)-v) and other water;
xiii) 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:

xiv) 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
xv) 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.

Mine water storages are used to contain surface water runoff and groundwater ingress collected within the mining pit and runoff from the MIA area. BME uses North Pit and MWD1 to manage MAW generated on site or within the operational pit area. Their features are summarised in Table 3.3.

Mine Water Dam (MWD1) was constructed for the dual purpose of storing MAW dewatered from the pit and collecting runoff from the nearby MIA. The details of MWD1 are presented in Table 3.3 below.

North Pit is a previously mined pit shell that still serves some function to collect runoff from mine affected catchment areas north of South Pit that do not report back to South Pit. In the situation of an overtopping event from North Pit, runoff reports to MWD1 directly to the west. The details of North Pit are presented in Table 3.3 below.

BME further manages accumulated MAW on site through use in dust suppression (Refer to Section 3.3.1) and managing pit operability via temporary storage of mine water within South Pit (Refer to Appendix A:).

TABLE 3.3: MINE AFFECTED WATER STORAGES

ID	Description	Catchment Area	Full Supply Volume
MWD1	Proposed dam sized to capture runoff from MIA and storage of dewatered inventory from North Pit. Dam used for supplying dust suppression demands for MAW catchments.	0.6 ha	20.4 ML
North Pit	Previously North Pit was planned as a bulk water storage of mine affected water dewatered from South Pit. North Pit still has the ability to function for this purpose despite its volume being significantly reduced due to pit overburden deposition reducing its capacity.	5.28 ha	274.19 ML

BME will implement a flexible mine water management strategy during operations that continuously reviews the monitoring and management strategy for accumulated mine water to ensure there are no uncontrolled overflows.

MIA areas have been constructed in areas above the 1 in 1000-year pre-mining flood level.

3.2 Sediment Water

Sediment water is defined as runoff from disturbed landforms including overburden dumps, topsoil dumps, cleared areas and rehabilitation that is not yet established. This water typically contains elevated suspended solids and should be managed using sediment dams. Sediment dams ensure that suspended solids are contained and treated (i.e. settled) prior to overflow to the receiving environment during rainfall events above the design capacity of the dams.

Three sediment dams currently manage sediment runoff at the BME site (Refer to Table 3.3). Several additional sediment basins are proposed for construction as the BME site progresses into future phases and additional sediment capture is required. The location of sediment dams has been developed based on topographical low points surrounding the OOPDs and other sediment water catchments. Additional sediment dams may also be required during operations as a control for runoff from topsoil stockpiles if they are located outside of the catchment of existing sediment dams (Refer to Section 5.3.5), refer to the BME Topsoil Management Plan for further details.

All sediment dams have been sized as per BPESC document methodology for “Type D’ sediment basins (IECA , 2018). The sediment basins total volume is sized to allow for a settling zone volume to contain a 5 day, 85th percentile rainfall events and a storage zone volume equal to 50% of the settling volume. Inputs for the sediment dam sizing are shown in Table 3.4. The various sediment dams may opportunistically provide additional water to meet dust suppression demands.

TABLE 3.4: SEDIMENT DAM SIZING INPUTS (IECA , 2018)

Parameter	Value	Comments
Y% (constant Table B28 of IECA)	Y% = 85%	Conservatively adopted a parameter for basins discharging to sensitive receiving waters.
$I_{(1\ year,\ 120\ hour)}$[1]	0.963 mm/hr (116 mm) BOM IFD 2016 at Latitude: -21.80 and Longitude 148.15	-

Parameter	Value	Comments
K1 (constant Table B28 of IECA)	23.2	Conservatively adopted a parameter for basins discharging to sensitive receiving waters.
K2 (constant Table B28 of IECA)	12.6	Conservatively adopted a parameter for basins discharging to sensitive receiving waters.
Y%, 5-day runoff ($R_{(y\%, 5day)}$) (Eqn B36 of IECA)	K1. $I_{(1\ year,\ 120\ hour)}$+K2 = 34.94 mm (Rounded to 30 mm)	-
Soil Hydrologic Group (Table B31 of IECA)	Group D (clay)	-
Cv (volumetric runoff coefficient) (Table B31 of IECA)	0.56	-

3.3 Regulated Structures

Conditions H1 to H3 in the EA require:

> *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.*
>
> *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.*
>
> *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).*

A Preliminary Consequence Category Assessment (CCA), including a report and certification statement, has been completed by Engeny (Engeny, 2022) as part of the SWIA that supported the initial approval for the BME Mine. The CCA was based on the concept design, intended operational strategy and expected contaminant concentrations of stored contents for each structure.

Table 3.5 summarises the outcomes of the Preliminary CCA. Of the water storages and levees assessed, the North Pit Levee and South Pit Levee structures (if required as part of future operations) were assessed to be regulated structures. The Preliminary CCA will need to be revised and re-certified utilising the as-constructed information for these levees.

TABLE 3.5: PRELIMINARY CONSEQUENCE CATEGORY ASSESSMENT OUTCOMES AND DETERMINATION

Structure	Scenario	Category of Harm	Consequence Category	Regulated	Determination
MWD1	Failure to Contain - Seepage	Harm to Humans	Low	No	Uncontrolled overflows are only anticipated to occur during flow events in which water quality will be significantly diluted. Overflows will predominately flow into the North pit, therefore presenting a low-risk harm.
		General Environmental Harm	Low		
		General Economic Loss or Property Damage	Low		
	Failure to Contain - Overtopping	Harm to Humans	Low		
		General Environmental Harm	Low		
		General Economic Loss or Property Damage	Low		
	Failure to Contain - Dam Break	Harm to Humans	N/A – dam break not applicable to fully excavated storage		
		General Environmental Harm	N/A – dam break not applicable to fully excavated storage		
		General Economic Loss or Property Damage	N/A – dam break not applicable to fully excavated storage		
		General Environmental Harm	Low		
		General Economic Loss or Property Damage	Low		
	Failure to Contain - Overtopping	Harm to Humans	Low		
		General Environmental Harm	Low		
		General Economic Loss or Property Damage	Low		
	Failure to Contain - Dam Break	Harm to Humans	Low		
		General Environmental Harm	Low		

Structure	Scenario	Category of Harm	Consequence Category	Regulated	Determination
		General Economic Loss or Property Damage	Low		
North Pit Levee	All	Harm to Humans	Low	Yes – regulated structure	North Levee provides 1:1,000-year flood immunity for operational pits and are therefore determined to be regulated structures under the Manual criteria.
		General Environmental Harm			
		General Economic Loss or Property Damage			

3.4 Water Demand and Supply

3.4.1 Water Demands

As there is no coal processing on site and the Run of Mine (ROM) coal will be transported off-site for washing and stockpiling, as such there are no process water demands.

Dust suppression will be required on all unsealed roads when trafficked in the absence of adequate rainfall to reduce dust generation on site. Dust suppression demands have been estimated using daily evaporation rates (mm/day) and an internal road watering width of 30 m. Internal road length have been determined based on current mine planning, and have been used to estimate annual dust suppression water demands. The annual internal road dust suppression demands are presented in Table 3.6. It has been assumed that when the daily rainfall total exceeds the daily evaporation rate, further dust suppression will not be required.

Dust suppression demands will be sourced from the mine water system preferentially, external supply of water to the mine is only expected to be required in extended dry periods where demands exceed the mine water inventory.

TABLE 3.6: DUST SUPPRESSION WATER DEMAND

Length of Haul Road	Internal Road Dust Suppression Demand (ML/yr)
9,800 m	350

3.4.2 Water Supply

Site water operational demands (which are primarily dust suppression demands) will be sourced from the mine water system. These systems have been modelled to account for inflows due to rainfall, overland flow and groundwater ingress (pits).

Annual dust suppression demand shortfalls have been modelled (Refer to Appendix A:).

3.5 Erosion and sediment control

A range of measures for management of sediment-laden, non-mine affected waters are required as a part of the water management system at BME. An ESCP has been developed in accordance with EA Condition C35 as part of the EMS for BME (refer to Section 5.3.1). The ESCP documents the current and future sediment management structures and systems on site including design standards. The ESCP is scheduled for update prior to March each calendar year as per the Site EA conditions. This management plan addresses the location and period of service for each sediment structure on site.

3.6 Sewage Management

All effluent generated on site will be removed from the site by a licenced contractor at regular intervals. Maintenance and integrity testing of sewage related infrastructure will also be completed at regular intervals. A register will be maintained onsite to keep track of the amount of sewage generated, stored onsite and disposed of via a licenced contractor.

4. RISKS TO THE RECEIVING ENVIRONMENT

The potential surface water risks associated with BME include:

- Surface runoff from disturbed areas into receiving environment.
- Accumulated mine water within the operational pits (including groundwater ingress).
- Seepage, overtopping or dam failure of site water storages.
- Incidental runoff from chemical/ hydrocarbon spills.
- Overflows from sewage treatment systems.
- Flooding.
- Mine water release and/or uncontrolled releases.
- Water supply deficiencies impacting upon effective dust suppression.
- Saline and acid rock drainage.

Mining activities/features that have the most potential to cause erosion and/or generate sediment and adversely impact on the receiving environment if not properly managed are:

- Vegetation clearing.
- Topsoil stripping and stockpiling.
- Overburden dumps.
- Vehicle and equipment movements; and,
- Construction, operation and maintenance of roads, mine infrastructure and water management infrastructure.

These mining activities/features have the potential to cause:

- Removal and/or the loss of topsoil resources.
- Erosion, which can undermine built infrastructure.
- Sedimentation, which can cause:
  - Blocked or infilled drains.
  - Infilled dams.
  - Decline in water quality and degradation of local waterways.
- Uncontrolled discharges of sediment-laden water into local waterways.
- Increased operational costs due to remediation of erosion and desilting of drains and dams.

To demonstrate how BME provides for effective management of actual and potential environmental impacts resulting from water management, erosion and sediment associated with the mining activity, Table 4.1 outlines these risks and their mitigation measures.

TABLE 4.1: SURFACE WATER RISK ASSESSMENT

Risk	Impact	Mitigation
Uncontrolled releases	Negative impacts to the receiving environment	• Through management of the mine water system, the MWD1, North Pit and South Pit were modelled to have no uncontrolled overflows to the receiving environment during the life of mine under all climate scenarios. • Sediment dams were designed to contain an 85th percentile 5-day rainfall event based on guidance from the Best Practice Erosion and Sediment Control Guidelines (IECA, 2018). • Stored water within sediment dams will be opportunistically used for supplying dust suppression demands. • Routine inspections will be undertaken to monitor for any impending releases and mitigate the risk as it is identified. • Controlled release will comply with regulator-imposed release contaminant limits and other relevant conditions from the site-specific EA.
Spills or releases to ground and/or groundwater via seepage from the floor and/or sides of the MWD1 structure or dam break	Negative impacts to the receiving environment	• Seepage management measures. • Dam inspections and monitoring. • Surface Water Management Plan includes details on MAW dam management and controlled releases, as per EA conditions. • Ensure design and operating measures remain adequate through revision of water balance modelling as the SWMP is updated during operations. • Preferential re-use of on-site water supplies. • Mine water will be used for dust suppression demands. • MWD1 has been designed to be fully excavated such that dam break is not a possible mechanism of failure.
Flooding / Flooding of pit	Negative impacts to operations and potentially the receiving environment	• North Pit levee has been constructed to provide flood immunity for North Pit. • Levees and mine are not constructed within Watercourses. • MIA will contain appropriate drainage to avoid potential flood water interaction with contaminants. • Implement progressive rehabilitation as per the schedule and EA rehabilitation methods. • Design and construct regulated structure in accordance with flood modelling design parameters and relevant standards and guidelines. • Implement a wet-weather preparedness procedure. • Final void modelling indicated that void water levels will not overtop. • Final landform has been designed to minimise stored inventories within the final void.
Contamination to surface water or groundwaters due to spills of chemical/ hydrocarbon	Negative impacts to receiving environment	• A Waste Management Plan and Spill Response Procedure will be established as part of operational management protocols that will decrease or mitigate the chances of contamination.
Pipeline leaks or breaches	Negative impacts to receiving environment	• MAW pipelines to be equipped with gauges to measure flow and/or pressure. • Procedures for safe operation, monitoring and maintenance. • Placement of pipelines away from watercourses (where appropriate).

Risk	Impact	Mitigation
Footprint of proposed BME mine plan reducing overland flow into receiving waterways and impacting upon streamflow	Impacts on water quality and quantity	• Redirection, or segregation of minor tributaries and storm water overland flow paths. • Short-term period where stormwater is captured within a dedicated storage and dewatered to the receiving environment to reduce contamination of receiving environment.
Increased turbidity and sedimentation in nearby water bodies	Negative impacts to receiving environment	• Implementation of ESCP. • Progressive Rehabilitation. • Progressive clearing (i.e. minimising cleared footprint at any one point in time). • Receiving Environment Monitoring Program. • Soil and material stockpiles will be designed and placed away from water bodies/watercourses where possible. • Sediment dams were designed to contain an 85th percentile 5-day rainfall event based on guidance from the Best Practice Erosion and Sediment Control Guidelines (IECA, 2018). • Stored water within sediment dams will be opportunistically used for supplying dust suppression demands.
Water supply deficiencies impacting upon effective dust suppression	Impacts to function of mine and negative impacts to environment	• Re-use of accumulated mine water and dirty water. • Minimal water demands meaning maximum availability of site water for dust suppression. • Progressive rehabilitation. • Potential to enter into engagement with adjacent mines for access to surplus mine water (subject to approvals).
Saline and acid rock drainage (ARD)	Impacts to receiving environment	• Progressive rehabilitation will ensure minimal exposure of spoil material. • Storm water drains and levees designed to ensure segregation of water and minimise accumulation of mine water. • Segregation of mine and sediment laden waters. • Investigation will be carried out by the relevant staff/contractors if there is evidence of ARD seepage.
Unauthorised water storage access by livestock	Impacts to graziers and stock	• Exclusion fencing. • Agreements with landholders/graziers.
Overflows from sewage treatment system	Impacts to receiving environment	• Construction and operation in accordance with manufacturers specifications. • Regular maintenance.
Vegetation clearing	Loss of topsoil resources Erosion Sedimentation Increased operational costs	Minimise the clearing as far as reasonably practicable. Delineate the clearing areas and ensure that clearing is limited to this area. Restrict access to undisturbed and rehabilitated areas. Schedule clearing activities according to the monthly erosion risk rating. Erosion and sediment controls will be implemented prior to any clearing in accordance with this ESCP. Diversion of clean runoff around the clearing area.

Risk	Impact	Mitigation
		Capture of sediment runoff from the clearing area in sediment dams (where required) which will act to reduce the concentration of suspended solids prior to discharge into the receiving environment Receiving environment monitoring via the Receiving Environment Monitoring Program (REMP).
Release of sediment into great barrier reef catchment waters	Erosion Sedimentation	As above. Additionally, • The dominant land use within and surrounding the ML is grazing. As part of BME site, permanent erosion and sediment controls will be installed (e.g. sediment dams, clean water diversion drains, levees, etc.), thereby reducing the potential sediment load into great barrier reef catchment waters.
Topsoil stripping and stockpiling	Loss of topsoil resources Erosion Sedimentation Increased operational costs	Strip topsoil in moist conditions. Where practicable, immediately after stripping, topsoil to be placed in its final location within rehabilitation areas. Topsoil stockpiles to be situated away from concentrated overland flow paths. Topsoil stockpiles to be <4m in height with water-shedding tops and ripped if compacted. Diversion of clean runoff around topsoil stockpiles. Vegetate topsoil stockpiles: • Capture of sediment runoff from topsoil stockpiles in sediment dams or via other sediment such as Type 2 and Type 3 controls combined with revegetation of stockpiles as soon as practicable.
Construction and management of OOPDs	Erosion Sedimentation	Diversion of clean runoff around the OOPDs. Capture of sediment runoff from the OOPDs in sediment dams which will act to reduce the concentration of suspended solids prior to discharge into the receiving environment. Receiving environment monitoring via the REMP.
Vehicle and equipment movements	Erosion Sedimentation	Vehicles and equipment will only be permitted to drive on haul roads and access tracks. Restrict vehicle and equipment access to undisturbed areas and rehabilitated areas: • Dust suppression on haul roads and access tracks.
Construction, operation and maintenance of water management infrastructure	Erosion Sedimentation Uncontrolled discharges of sediment-laden water into local waterways	Routine/regular inspections of erosion and sediment control infrastructure to assess their condition and mitigate the risk of uncontrolled releases not in accordance with their design (Refer to Sections 6.2 and 6.3). Desilting of sediment dams before the volume of accumulated sediment reaches >50% of the capacity of the sediment dam (at minimum) Annual inspections of regulated structures (i.e. the North Pit Levee) (Refer to Section 6.1). Annual reviews of this ESCP (Refer to Section 7). • Development and implementation of emergency and incident response plans (Refer to Section 7.2.1).

5. MITIGATION AND MANAGEMENT MEASURES

The following sections describe the control measures and/or procedures in place to prevent or mitigate the potential surface water impacts at BME.

5.1 Emergency and Contingency Planning

To assist with complying with EA general conditions, if any surrounding surface water users or BME personnel indicate they have become aware of adverse surface water impacts as a result of the site's activities, an investigation will be undertaken, which will include:

- Identification of potential contributing factors including upstream influences.
- Assessment of surface water monitoring data, including stream flow data against background (upstream) trends to identify any anomalies or causes.
- Where the impact is potentially attributable to the site's activities, appropriate make good provisions as well as mitigation and management strategies will be developed and implemented.

5.2 Classification of Surface Runoff from Disturbed Areas

Disturbance activities for the site operations include a mining pit, out of pit dumps, topsoil storage area, mine infrastructure hardstand areas, access and internal roads. As outlined in Section 3.1, runoff from these areas could contain sediment and other contaminants above natural surface water runoff concentrations. The source of the runoff will influence the contaminant types and concentrations, however generally there are two overarching categories:

- Runoff from cleared areas, overburden dumps or roads that would be expected to have elevated sediment load; and,
- Runoff from areas that may contain contaminants in addition to sediment– i.e. Mine Affected Water.

Under the EA, the strategies for the mitigation and management of these categories differ to ensure they are suitably managed to protect the receiving environment and associated environmental values. Erosion and sediment control strategies are implemented for runoff in which sediment is the primary contaminant of concern and are addressed in the ESCP, whereas more conservative mine water management systems have been developed for waters containing other contaminants (see Section 3.1.2).

5.3 Proposed Management Measures

The management measures required at BME at end of mine life are described within the "*Broadmeadow East Mine – Progressive Rehabilitation and Closure Plan"* by RPM Global dated 29 September 2023. This includes all water management structure required for mine affected and sediment affected surface water runoff at the maximum mine plan extent. An extract from the PRCP has been provided in Figure 5.1 below.

The current control and management measures are outlined in following sections.

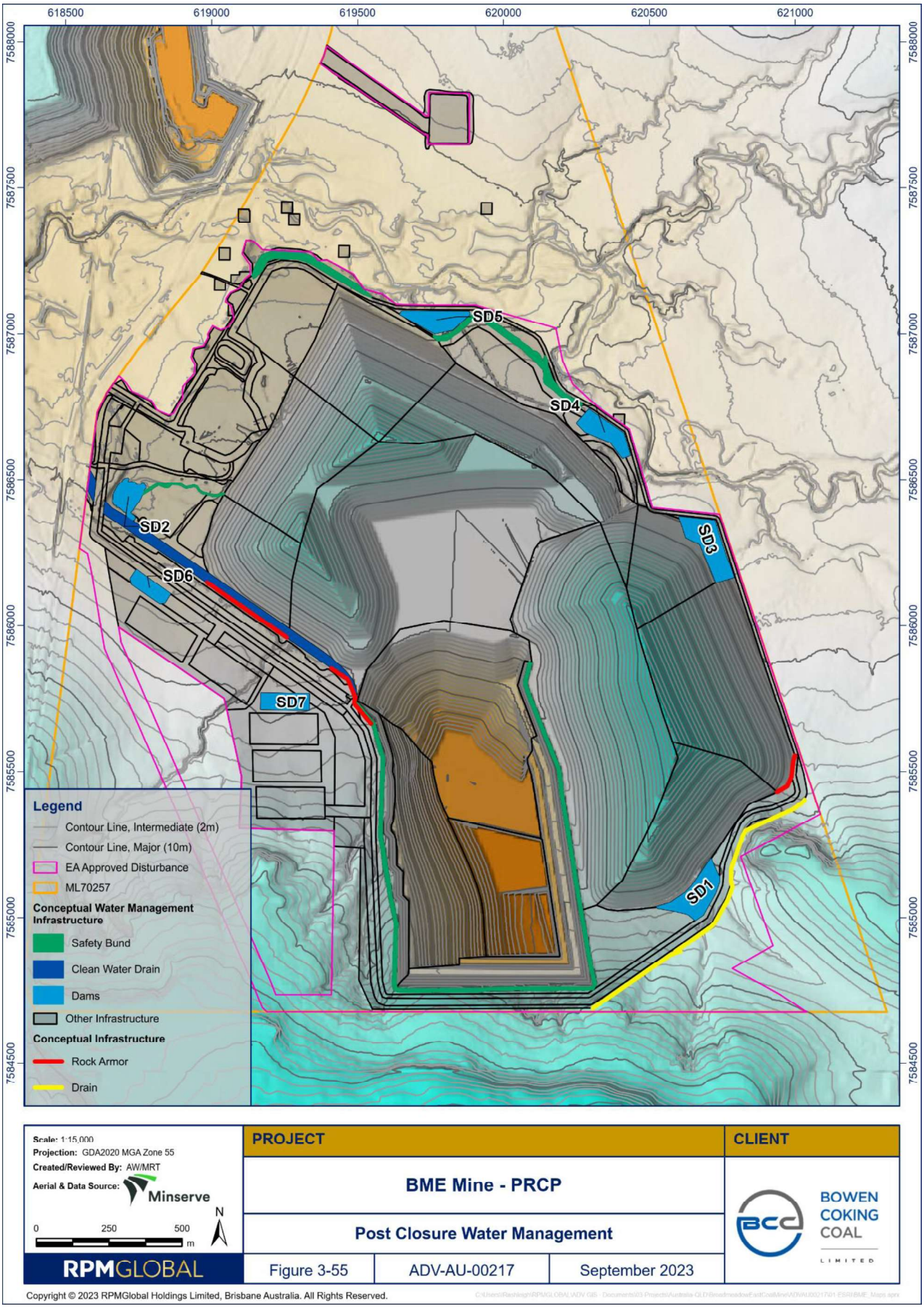


Figure 5.1: PRCP Post Closure Water Management

5.3.1 Sediment Affected Water Management

This ESCP has been developed to ensure suitable management of erosion and sediment at the BME site. The following sections should be used to understand the erosion and sediment controls and design standards that are implemented on site. They outline appropriate design and selection of erosion and sediment controls specific to the location, extent and method of disturbance. The following sections should be considered when planning any disturbance activities on site to assess which additional erosion and sediment controls are required on a project-by-project basis. Proposed erosion and sediment controls based on the current mine plan are also summarised in more detail in Section 5.3.

5.3.1.1 Selection and Design

Each proposed disturbance activity at the BME site requires a case-by-case assessment to determine the most effective and appropriate erosion and sediment controls. Table 5.1 provides a guide for factors that should be considered in the planning phases for erosion and sediment controls. Examples are provided for disturbance activities that would be considered higher risk and require a greater level of planning.

TABLE 5.1: CONSIDERATIONS FOR ESC SELECTION AND RISKS

Aspect	ESC Consideration	Comments
Water Type	Assess the classification/s of runoff (i.e., MAW, sediment water, clean water) to be managed as part of the activity. If MAW is expected, it must be managed under the SWMP.	Consult with your supervisor if unsure about the classification of waters.
Location	Define the full extent of disturbance including the need for access roads, laydown areas, power supply, pipelines, etc.	Activities located near watercourses or drainage paths present a higher risk to the receiving environment. Activities in floodplains may be at risk of flooding during flow events. Flood modelling has been completed for the site and can be used to assess if the activity is located within a floodplain (Refer to the SWIA).
Catchment	Assess the size of the catchment upstream of the disturbance activity.	Diversion of upstream clean water catchments around the disturbance activity will minimise the erosion and sediment risks.
Topography / Slope	Assess the slopes and drainage paths that will be encountered both before, during and after the activity.	Steep slopes (i.e., waste rock dump batters/steep natural terrain) generally have low structural stability and pose the greatest erosivity potential.
Climate and Duration of Works	Assess the expected duration of works and if it will require temporary controls or a long-term management strategy. Assess if the disturbance will occur during the wet season.	Most disturbance activities for BME will require long-term or permanent management strategies until rehabilitation is completed and will therefore need to consider the impacts of higher rainfall during the wet season. Large scale disturbances in complex environments may require a design and monitoring program issued by a Certified Professional in Erosion and Sediment Control (CPESC). This may influence a requirement to stage works to reduce catchment areas and conduct an

Aspect	ESC Consideration	Comments
		inspection and maintenance regime for the erosion and sediment controls.
Soil/Spoil	Define what soil/spoil types are expected to be disturbed and their properties.	Activities that will expose dispersive material present a higher risk of erosion during rainfall/flow events and may require amelioration or combinations of controls.
Mine Plan Phase	Final landform design will influence erosion and sediment controls.	Rehabilitation and closure should be considered in erosion and sediment control selection and design.

5.3.1.2 ESC Measures

The main erosion and sediment control measures to be used at the BME site include:

- Redirection of runoff from clean water catchments around disturbed areas via diversion drains and levees to discharge into natural watercourses.
- Installing appropriate erosion and sediment control measures/structures such as silt fences, catch drains and sediment dams prior to any land disturbance.
- Minimising all disturbed areas by progressive rehabilitation/stabilisation as soon as practicable.
- Clearly identifying and delineating areas required to be disturbed and ensuring that disturbance is limited to those areas.
- Clearing as little vegetation as required, leaving mulch on cleared areas as late as possible and minimising machinery disturbance outside of these areas.
- Interception of runoff from disturbed landforms, including overburden dumps, topsoil dumps, cleared areas and rehabilitation that is not yet established, to settle out suspended solids prior to discharge back to the natural system.
- Restricting access to rehabilitated and undisturbed areas; and
- Regular inspections and maintenance of all erosion and sediment control works to ensure that they are operating in accordance with their design principles.

5.3.1.2.1 Rainfall, Timing and Duration

Most disturbance activities at the BME site will be long-term and therefore erosion and sediment control measures will have to account for seasonal variability in climate and rainfall conditions. As shown in Table 5.2

, the BME site experiences a clear wet and dry season in which the erosion risk rating, based on average monthly rainfall depths, is moderate to high for the wet season months and low to very low for the dry season months.

Strategies employed under the ESCP that account for seasonal fluctuations in erosion risk include:

- All permanent erosion and sediment control measures should be designed based on the wet season rainfall depths and/or additional controls proposed during the wet season months; and
- Where practical, high risk disturbance activities (e.g., those in close proximity to watercourses or earthworks involving dispersive material) should be undertaken during the dry season.

Some additional guidance for scheduling of disturbance activities and stabilization/rehabilitation is provided in the Broadmeadow East Progressive Rehabilitation and Closure Plan undertaken by RPM Global.

TABLE 5.2: GUIDANCE FOR SCHEDULING AND STABILISATION OF DISTURBANCE FOR NON-ACTIVE AREAS

Months	Erosion Risk Rating	Timeframes for Disturbance/ Clearing	Timeframes for Stabilisation at Completion of Works	Stabilisation Guidance for Incomplete Works	Other Construction Guidance
May - October	Very Low	Limited to eight weeks if rainfall is reasonably possible.	For non-active areas, disturbed soil surfaces are stabilized with minimum 60% cover within 30 days of completion of works if rainfall is reasonably possible or otherwise in accordance with PRCP Schedule rehabilitation assuming adequate sediment control is located downgradient of disturbed areas.	Unfinished earthworks are suitably stabilized if rainfall is reasonably possible, and disturbance is expected to be suspended for a period exceeding 30 days.	-
April	Low	Limited to eight weeks.	For non-active areas. disturbed soil surfaces stabilized with minimum 70% cover within 30 days of completion works or otherwise in accordance with PRCP Schedule rehabilitation assuming adequate sediment control is located downgradient of disturbed areas.		-
November - December	Moderate	Limited to six weeks of work.	For non-active areas, disturbed soil surfaces stabilized with minimum 70% cover within 20 days of completion of works or otherwise in accordance with PRCP Schedule rehabilitation assuming adequate sediment control is located downgradient of disturbed areas.	Unfinished earthworks are suitably stabilized if rainfall is reasonably possible, and disturbance is expected to be suspended for a period exceeding 20 days.	Staged construction and stabilization of earth batters (steeper than 6H:1V) in maximum 3m vertical increments wherever reasonable and practicable.
January	High	Limited to four weeks of work.	For non-active areas, disturbed soil surfaces stabilized with minimum 75% cover within 10 days of completion of works or otherwise in accordance with PRCP Schedule rehabilitation assuming adequate sediment control is located downgradient of disturbed areas.	Soil stockpiles and unfinished earthworks are suitably stabilized if disturbance expected to be suspended for a period exceeding 10 days.	

5.3.1.2.2 Erosion Control

As defined in the BPESC document (IECA , 2018), erosion control measures concentrate on preventing, or at least minimising, soil erosion, especially raindrop impact erosion. The key erosion controls and strategies used on site in line with the principles of the BPESC document are:

- Works will be scheduled to minimise the area of active disturbance at any one time.
- Erosion control measures shall be installed prior to clearing and grubbing operations wherever possible. Where access to an area is required prior to installation, erosion control measures shall be installed concurrently with clearing operations.
- Exclusion or 'No-Go Zones' will be shown on any design drawings.
- Diversion of clean surface water runoff around areas disturbed by mining activities and/or clearing.
- Erosion controls (e.g., erosion control mats, channel linings, level spreaders and outlet protection).
- Surface roughening techniques, such as walking a hillside with tracked equipment on the contour, may also be employed to minimize erosion potential for steeper OOPD faces prior to rehabilitation.
- It is preferable that stripped topsoil be immediately placed in its final location in rehabilitation areas, however if it is to be stockpiled, the stockpiles should be <4m in height and flat-topped but slightly water-shedding and ripped if compacted. Indicative future topsoil stockpile locations are shown in Figure 1.2, however the controls discussed in this ESCP apply to any topsoil stockpile location.
- Dust emissions will be controlled using water trucks on roads and sprays will be used if required to control dust at product stockpiles.
- Any disturbed areas that are not required during the operation of the mine will be progressively rehabilitated according to the site mine plan and rehabilitation strategy; and,
- Erosion and sediment controls are to be maintained until final rehabilitation/stabilization has been completed and a stable landform is achieved in accordance with the EA and rehabilitation requirements.

Standard erosion control construction and operation methodologies from IECA (2018) are provided in Appendix C:, including for heavy mulching, rock mulching, revegetation and surface roughening.

5.3.1.2.3 Revegetation

Disturbed areas not forming part of the operational rehabilitation activities should be revegetated to stabilize the surface and reduce the potential for erosion. Revegetation is to be undertaken as soon as possible following the completion of disturbance activities for non-active areas. Appendix 5 of the EA sets out the revegetation methods and success criteria that must be implemented and measured.

5.3.1.2.4 Management of Dispersive Soils

Generally, dispersive soils do not readily settle out in water due to the chemical charges on each soil particle. This may create elevated levels of suspended solids within the water. The primary mitigation measure used at site in the management of dispersive soils is to ensure erosion is minimized via utilizing the following erosion control measures:

- Establishing vegetation cover to protect against soil detachment.
- Covering the dispersive soil with a non-dispersive capping, topsoil or mulch.
- Application of a chemical binder (can be used on haul roads); or
- Improving the soil structure via soil amelioration through the addition of gypsum and/or organics into the soil.

5.3.1.2.5 Topsoil Management

Specific controls are required for the management of topsoil, as outlined below in Table 5.3 An indicative topsoil stockpile locations for the BME site is shown in the figures in Figure 1.2. The exact location of topsoil stockpiles within the allowed disturbance footprint for the site will be determined during operations. The controls discussed in this ESCP apply to topsoil stockpiles regardless of their location.

TABLE 5.3: EROSION AND SEDIMENT CONTROLS FOR TOPSOIL MANAGEMENT

Control	Measure
Erosion	Where possible, topsoil is to be stripped in moist conditions to reduce deterioration in topsoil quality and dust generation and only be stockpiled

Control	Measure
	when no reshaped overburden is available for direct placement and spreading. If topsoil is stockpiled, a maximum stockpile height should be no more than 4m. Consideration should be given to sowing stockpiles with a sterile cover crop and permanent pasture species to accelerate stockpile stabilisation. To protect against detachment or dispersion, a vegetation cover, non-dispersive capping or mulch is recommended. Soil amelioration through the addition of gypsum and/or organics can also be used to improve the soil structure.
Drainage	Clean water should be diverted around the stockpiles and stockpiles should not be placed within concentrated flow pathways so not to encourage erosion of the loose material.
Sediment	Until there is sufficient vegetative coverage of the stockpile, sediment control will be required. Depending on the size of the stockpile, either sediment basins (large stockpile) or more minor controls such as a sediment fence or trench (for small stockpiles) can be constructed around the down-slope perimeter of the stockpiles to provide temporary sediment control until vegetation becomes established.

5.3.1.2.6 Drainage Controls

Drainage controls prevent or reduce soil erosion caused by concentrated flow by managing the movement of clean water, sediment water and MAW through the site. Drainage controls to be implemented at the BME site include:

- Clean water diversions and levees are utilised to divert clean water runoff around the disturbed mine areas, wherever practicable. Other minor banks and drains shall be installed where required.
- Catch drains are utilised to collect and convey concentrated stormwater flows in a non-erosive manner to the sediment control (e.g., dam). Earthen diversion banks and berms may be utilised to assist in reducing site erosion by reducing the length of slope (and therefore potential soil loss), increasing the time of concentration of overland flow and directing overland flow towards a stable outlet point or sediment control.
- All diversion drains and diversion banks will be designed with stable batter slopes.
- Discharge from each diversion structure will be via a level spreader or rock chute to ensure that the concentrated surface flow is transitioned back to sheet flow in a way that minimises erosion downslope of the outlet.

Standard drainage control construction and operation methodologies from IECA (2018) are provided in Appendix C, including for erosion control mats, catch drains, chutes and check dams.

5.3.1.2.7 Sediment Controls

The BPESC document (IECA, 2018) defines sediment controls as measures that concentrate on trapping sediment displaced by up-slope soil erosion. Sediment controls can be grouped into three categories (Type 1, Type 2 and Type 3) based on their ability to trap a specified size/volume of sediment (refer to Table 5.3). Examples of Type 1 sediment controls include sediment basins, examples of Type 2 sediment controls include rock filter dams, sediment weirs and filter ponds, and examples of Type 3 sediment controls include sediment fences and buffer zones.

Appendix C contains standard sediment control construction and operation methodologies from IECA (2018), including for sediment fences, mulch filter berms, fibre rolls and grassed buffer rolls.

Soil loss due to erosion can be estimated using the Revised Universal Soil Loss Equation (RUSLE) which takes into account the soil characteristics, slopes, catchment size and other factors such as ground cover. The RUSLE equation is:

$$A = K \times R \times LS \times P \times C$$

Where:

- A is the estimated soil loss in tonnes/hectare/year.

- K is the soil erodibility factor derived from Table E4 of the BPESC document (Refer to Appendix D). An additional 20% increase should be applied to account for dispersive soils (those with Emerson Aggregate Class 1 or 2).
- R is the rainfall erosivity factor. It can be derived from Table E1 of the BPESC document (Refer to Appendix D) or calculated using the following equation where S is the 2-year Average Recurrence Interval (ARI) 6-hour rainfall event for the Project/Disturbance location:

$$R = 164.74 \times (1.1177^{S}) \times S^{0.6444}$$

  Using BME site coordinates (-21.8475, 148.125), S was identified as 10.7 from the Design Rainfall Data System. Based on this, R has been identified as 2492 for the BME site.
- LS is a variable dependant on the length and slope of the catchment and is derived from Table E3 of the BPESC document (Refer to Appendix D:).
- P is a variable representing erosion practises and can be derived from Table E11 of the BPESC document (Refer to Appendix D:). Typically, 1.3 is the default conservative value applied for construction periods.
- C is a variable representing cover and can be derived from Tables E6 to E10 of the BPESC document (Refer to Appendix D). Typically, 1.0 is the default conservative value applied for construction periods representing no ground cover or management.

Based on the estimated soil loss using RUSLE and the catchment area for the Project/Disturbance, Table 5.4 provides guidance on the type of sediment control (Type 1, Type 2 or Type 3) that would be most appropriate to manage sediment from the Project/Disturbance. Type 1 sediment controls (i.e. sediment dams) will be the primary means of managing sediment loss from the BME OOPDs.

TABLE 5.4: SEDIMENT CONTROL STANDARDS (IECA , 2018)

Catchment Area (m^2)	Soil loss (t/h/yr)			Soil loss (t/h/month)		
	Type 1	Type 2	Type 3	Type 1	Type 2	Type 3
250	N/A	N/A	[4]	N/A	N/A	[4]
1000	N/A	N/A	All cases	N/A	N/A	All cases
2500	N/A	>75	75	N/A	>6.25	6.25
>2500	>150	150	75	>12.5	12.5	6.25
>10,000	>75	N/A	75	>6.25	N/A	6.25

Sediment Dams

As discussed in Section 3.3 sediment dams form a key part of the erosion and sediment control management system for the BME site, ensuring that runoff from overburden and disturbed areas, which may contain elevated concentrations of suspended solids, is contained and settled prior to overflow to the receiving environment during rainfall events above the design capacity of the dams. Indicative locations for the four proposed sediment dams are shown in Appendix A. All four sediment dams were sized in accordance with the BPESC document for "Type D" sediment basins (IECA, 2018). The total volume of each sediment basin is comprised of a settling zone equal to a 5-day, 85th percentile rainfall event, and a storage zone volume equal to 50% of the settling volume. If sediment dams contain dispersive suspended sediment particles, then it may be helpful to add chemical flocculants to the sediment dams to reduce suspended solid concentrations further.

5.3.1.3 Waterways

Some considerations for BME Project works within waterways include:

- Construction of any waterway crossings should occur during periods of no flow (where possible).
- Where possible, utilise already cleared areas or breaks in riparian vegetation to minimise additional clearing.
- Minimise the cutting of banks and the placement of fill within the low flow channel.
- Divert instream flows around or through disturbed areas (e.g., bunds, culverts or piping) where required.

- Orientate crossings and culverts as close to perpendicular to the low flow channel as is practical.
- Ensure low flow culverts and causeways have sufficient capacity to minimise erosion and scour and limit ponding. Where velocities through the structure exceed the erosive velocities for the bed material, suitable protection needs to be provided; and
- Maximise the integration of natural vegetation into any erosion control or banks stabilisation works.

5.3.2 Mine Affected Water Management

5.3.2.1 Management of Groundwater Ingress

Groundwater studies have confirmed that groundwater will enter the open cut workings. The regional pre-mining groundwater levels relative to the mining footprint range from 271 – 285 m AHD (KCB, 2021). Based on the known water quality of the groundwaters it is expected the ingress will have potential for elevated salinity concentrations which is a potential contaminant source to surface waters.

The water balance modelling for the site mine water management system takes into consideration groundwater ingress rates and quality (Refer to Appendix A), such that it is expected to be managed during operations.

Further detail on mitigation and management strategies for groundwater are outlined in the GMMP.

5.3.2.2 Chemical and Hydrocarbon Storage

The storage of chemicals and hydrocarbons will be required as part of ongoing operations. Any structures for chemicals and hydrocarbons will be constructed in line with the containment and spill response requirements of *Australian Standard 1940 – The Storage and Handling of Flammable and Combustible Liquids* (DES, 2018). However, they still remain a potential source of contaminants for the site via unplanned or accidental release from operational equipment. Spill response mitigation and management measures and procedures will be implemented through the Environmental Management System (EMS).

5.3.2.3 Flood Protection

Flooding of the pit was identified as a potential impact/risk. North Pit Levee is in place as the primary flooding control to mitigate the risk of flooding ingress into the pit up to the 1:1000 AEP design flood event.

5.3.2.4 Uncontrolled Releases

Although not explicitly mentioned in EA0002465, the risk assessment in Section 4 has identified uncontrolled releases as a risk to the receiving environment due to its potential negative impact and therefore the appropriate mitigation measures have been outlined in the case of this event occurring.

BME will implement a flexible mine water management strategy that monitors and manages accumulated mine water to ensure there are no uncontrolled overflows. In addition to reducing accumulated mine water through dust suppression, the active pit operability target can be reduced to allow for temporary storage of mine water within the active pit.

The MWD1, North Pit and South Pit are modelled to have no uncontrolled overflows to the receiving environment during the life of mine under all climate scenarios (Refer to Appendix A). The integrated use of these MAW storages (i.e. relying on South Pit for excess MAW storage) is such that any uncontrolled releases should not occur. Routine inspections should also be undertaken in accordance with Section 3.6.

Sediment dams were designed to contain an 85th percentile 5-day rainfall event based on guidance from the Best Practice Erosion and Sediment Control Guidelines (IECA, 2018) (Section 3.1.2). Stored water within sediment dams will be opportunistically used for supplying dust suppression demands, however passive overflows will occur during rain events larger than the design capacity of the structures.

5.3.2.5 Saline and Acid Rock Drainage

Saline and acid rock drainage have been listed in EA0002465, under condition C31 as one of the components to be included in the WMP. It has also been outlined in the risk assessment in Section 4 as a risk to the receiving environment.

Saline and acid rock drainage management is necessary to ensure that runoff and/or leachates do not adversely affect the receiving environment. Saline and acid rock drainage can occur when mined materials are exposed to water and air (RGS, 2021).

In July 2021, RGS completed a mine material assessment which found that the samples analysed as part of the report were 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 (RGS, 2021). Due to the low risk of saline and acid rock drainage, source minimisation will be the management and mitigation method applied.

These measures include:

- Progressive rehabilitation to minimise the duration that mined materials are exposed to water and air, thereby minimising the potential for saline and acid rock drainage to occur.
- The volume of storm water that is allowed to come into contact with disturbed areas of the mine will be minimised through diversion drains. The majority of the undisturbed storm water catchment upstream of the mine footprint (in the south) has been directed around the mine and into Hat Creek via a diversion drain.
- A flood protection levee has been constructed around North Pit so that floodwaters from Hat Creek will not be allowed to come into contact with disturbed areas of the mine.
- Runoff from overburden dumps, topsoil dumps, cleared areas and rehabilitation that is not yet established will be diverted into sediment dams via drains at the toes of these landforms. The sediment dams reduce the concentration of suspended solids in the runoff, before the runoff is allowed to overflow from the sediment dams into Hat Creek during rainfall events.
- Runoff from the active mining pit and MIA is diverted into dedicated mine-affected water storages.
- Routine and regular inspections and monitoring of dams will be carried out to ensure they are being operated in accordance with the design specifications and to track their water quality.
- The receiving environment will be monitored for signs of saline / acid rock drainage on a regular basis through the REMP.

If staff/contractors notice evidence of saline / acid rock drainage at the site, an investigation will be carried out and the source of the saline / acid rock drainage will be isolated as stated in EMS procedures.

5.3.2.6 Controlled Mine Water Release

Controlled mine water release has been identified as a potential risk to surface and receiving waters in Section 4.

Mine water release is authorised for the site water management system when the EA mine water release conditions are met. Controlled mine water releases are authorised to be undertaken from MWD1 and North Pit via a pumped transfer to the one release point RP1 on Hat Creek during natural flow events to provide dilution to the release flows. The location of RP1 is outlined in Table 5.1 while the location of MWD1 and North Pit is shown in Figure 1.2. The natural flow conditions dictate the opportunities for mine water release within the receiving environment. Discharging compliant mine water to these existing natural flows will occur through the discharge pipeline.

TABLE 5.1: MINE AFFECTED WATER RELEASE POINTS, SOURCES AND RECEIVING WATERS

Release Point	Easting (GDA20)	Northing (GDA20)	Mine Affected Water Source and Location	Monitoring Point	Receiving Waters Description
RP1	619279	7587480	Mine affected water - MWD1 and North Pit	MP2	Hat Creek

The discharge pipeline will function for controlled mine water release in the following ways:

- Controlled release will be via a fixed poly pipeline attached to a concrete structure located at the proposed RP1.
- MWD1 has been constructed and is being utilised for MAW storage.
- One release location directly into Hat Creek is authorised as per Table C1 of the EA (RP1). This will be approximately 7-10 m upstream from MP2 into the bed of Hat creek. The bed of Hat Creek varies between 2 to 10 meters wide. During rain events where discharge is required, flow is likely to be occurring throughout the entire bed. The placement of the concrete discharge point will be within the known flow channels of that location.
- During release events, release flow rates will be measured from the pumping device and the pump crew will manage the flow rate in accordance with the EA conditions (refer below) and associated operation EMS procedures.

More detail on the EA mine affected water release trigger levels and monitoring requirements is provided in Section 0.

6. MONITORING INSPECTIONS AND MAINTENANCE

Schedule C of EA0002465 outlines the all the site-specific conditions surrounding surface water and the monitoring requirements.

The following site-specific plans will outline the management of surface water during the construction, operational and decommissioning phases of the mine and will form an integral part of the EMS:

- This plan (inclusive of Water Management and Erosion and Sediment Control), which will be updated in accordance with EA conditions.
- Wet Weather Preparedness program.
- Surface Water Monitoring Procedures.
- Controlled Mine Water Release Procedures.
- Receiving Environment Monitoring Program (REMP):
  - The site REMP design document has been developed and used in development of this SWMP surface water monitoring program to ensure consistent monitoring locations between the SWMP.

These plans will also outline the routine assessment, reporting mechanisms and auditing of water quality data and WQOs, as well as mitigation measures and triggers for any corrective actions.

6.1 Annual Inspections and Monitoring

Surface water monitoring is one of the key performance indicators for the site. During the operational and decommissioning phases of the mine, surface water monitoring data from upstream and downstream of the site will be collected and analysed to determine the impact and effectiveness of the site's water management system. In addition, surface water monitoring data will be collected during any controlled releases of mine affected water to ensure compliance with the EA conditions. Surface water monitoring data will be used to:

- Build a dataset of local water quality and streamflow data that reflects the site-specific receiving environment.
- Define the baseline site-specific water quality conditions such that any changes from baseline conditions can be identified during operations.
- Be used to identify any impacts on the receiving environment, investigate sources of impacts and assign corrective actions where required; and,
- Assess the performance of the water management system and the effectiveness of any mitigation and management measures.

The documents which have been used to assist in the development of this surface water monitoring program are:

- Current EA (EA002465).
- Monitoring and Sampling Manual (DES, 2018).
- AS/NZS 5667.1:1998 Water Quality – Sampling (SAI Global, 1998), and,
- BME Receiving Environment Monitoring Program – Design Document (RPM Global, 2021).

In accordance with EA condition A8, all information related to surface water monitoring (e.g., field sheets, calibration certificates, monitoring data, etc.) must be kept for a minimum of five years (Refer Section 8.2).

Erosion and sediment control infrastructure at the BME mine site must be maintained in a proper manner in order to minimise the risk of environmental harm. To achieve this, routine and regular inspections of regulated structures (i.e. the North Pit Levee), sediment dams, and other erosion and sediment control infrastructure such as pipelines and pumping infrastructure should be carried out.

Regulated structures at the site must be maintained for the duration of their operational life in a manner that is consistent with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.

Under the EA, each regulated structure must be inspected each calendar year by a suitably qualified and experienced person. At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and the 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. The suitably qualified and experienced person must certify the report in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)* (DEHP (now DETSI), 2016).

Within 20 business days of receipt of the annual inspection report, the recommendations section of the annual inspection report, as well as details of any actions being taken in response to the recommendations, must be provided to the administering authority. If, following receipt of the recommendations and actions, the administering authority requests a fully copy of the annual inspection report, this must be provided to the administering authority within 10 business days of the request.

6.1.1 Routine and AD HOC Inspections

Routine and/or regular visual inspections of erosion and sediment control infrastructure should be conducted on an on-going basis. At a minimum, erosion and sediment control infrastructure should be inspected prior to each wet season.

Ideally the inspections should be performed and recorded by the same person(s) to ensure that relevant incremental changes are observed between each inspection. The visual inspections should be done for all components of erosion and sediment control infrastructure, including dam crests, upstream and downstream slopes, abutments, liners (if present), water reclaim systems, pipelines and pipeline crossings, diversion ditches and spillways. All observations shall be formally documented.

Inspections outside of routine should be conducted if any of the following events occur:

- A larger individual rainfall event or multiple close rainfall events outside of normal conditions.
- Unusual operating events such as rupture of a pipeline, particularly if on the slope or crest of a dam, sudden loss of pond water, sudden rapid rise of pond water.
- Unusual observations such as cracks, excessive settlements, sinkholes, large slope or foundation deformations, increased seepage, turbidity of seepage water; or,
- Instrument readings that deviate from historical trends, or are within “alert” action levels (e.g., trigger levels).

Special inspections after unusual events are necessary to evaluate whether there has been any damage requiring correction, any safety measures or special operating procedures that need to be implemented, or if there is a need to initiate emergency procedures.

6.2 Sediment Dams Inspections

Sediment dams at the BME site must be closely monitored as they have the potential for passive overflow to the receiving environment. At a minimum, sediment dams should be inspected prior to each wet season, and immediately before and after significant rainfall events. An inspection template is provided in Appendix B. During each inspection, the need to flocculate or desilt sediment dams should be assessed.

Flocculation may be required to assist with reducing the volume of suspended sediment within the dams. To determine if flocculation is required, soil from the sediment dam’s catchment will need to be tested to determine the particle size distribution and key characteristics (e.g. dispersity, salinity, pH) and/or a jar test can be carried out in which a sample of the sediment dam water is tested against a range of flocculants or coagulants. This information is required to determine the most appropriate flocculant type and the optimal dosing rates.

Sediment dams should be desilted, at minimum, before the volume of accumulated sediment reaches >50% of the capacity of the sediment dam. Silt may be removed using high-capacity sludge pumps or excavators and loaded into an enclosed truck or stockpiled on site. Sediment stockpiles should be located where they are not at risk of being washed back into the sediment dams or receiving environment.

6.3 Water Quality Monitoring

There is currently limited existing surface water quality data available for the site location. An important part of this SWMP is therefore continued baseline water quality monitoring under the site REMP in accordance with the surface water monitoring program described below.

6.3.1 Monitoring Locations

As shown in Figure 6.1 and Table 6.1, the surface water sampling locations for the surface water monitoring program are both upstream and downstream of the site to monitor any potential impacts. The monitoring locations align with the REMP design document and EA.

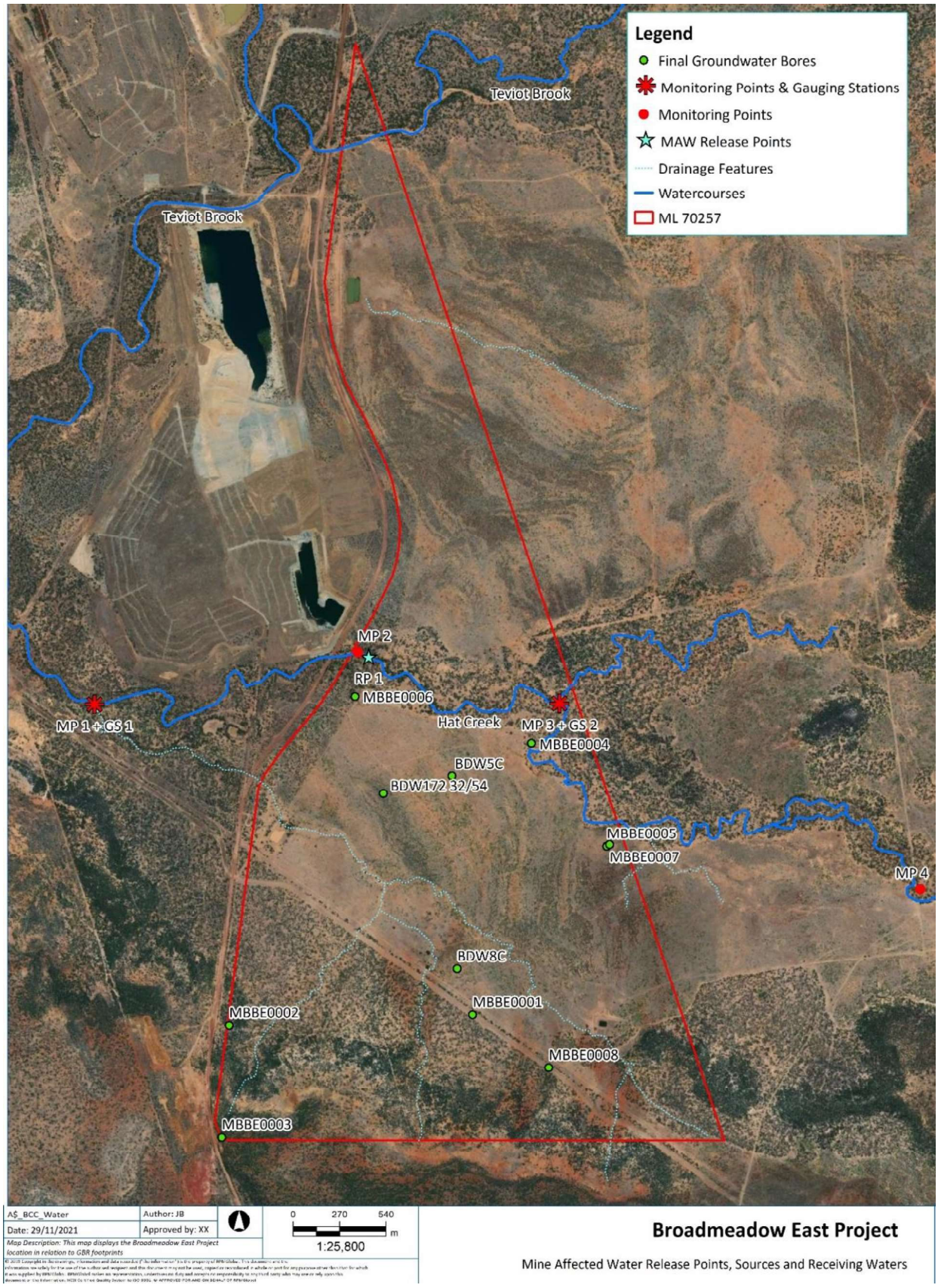


Figure 6.1: Water Quality Monitoring Locations

TABLE 6.1: WATER QUALITY MONITORING LOCATIONS

Monitoring Point	Status	Latitude	Longitude
MP1	Downstream	7587216	617623
MP2	Downstream	7587536	619175
MP3	Upstream	7587196	620310
MP4	Upstream	7586183	622473

6.3.2 Monitoring Frequency

Surface water quality monitoring is to be carried out on a monthly basis where possible and where stream flow occurs. The site area has experienced dry weather conditions and consequently due to ephemeral natural conditions of the waterways in the site area, flow events have been limited.

Specifically for REMP monitoring, it is recommended monitoring is conducted during wet season (November to March) to confirm streamflow. However, monitoring should be completed towards the end of wet season to avoid issues with accessibility and sampling safety. In addition to the wet season sampling, it is advised that monitoring should occur 2-6 weeks after flow events (SGM, 2023) which is in accordance with the EA (Refer to Section 6.2).

In addition to monthly sampling and/or REMP sampling, additional samples and monitoring is required during mine affected water release events in accordance with the EA (Refer to Section 6.2).

6.3.3 Water Quality Parameters

The water quality parameters listed in Table 6.2 should be monitored including both in-situ and laboratory (grab sample) testing.

In addition to water quality, streamflow gauging will be required during the operational phase of the site to inform release opportunities, assess impacts and to allow for ongoing refinement of surface water hydrology and water balance models. Continuous streamflow monitoring will be undertaken at two gauging stations, MP 1 and MP 3 along Hat Creek (refer to Figure 6.1 and Table 6.3).

TABLE 6.2: WATER QUALITY MONITORING PARAMETERS

Parameter	Comments
Surface Water: Physico-chemical	
pH	In situ – using monitoring instruments calibrated prior to each sampling event And Laboratory Testing.
Conductivity (Base flow & High flow)	
Dissolved Oxygen (DO)	
Turbidity	
Sulphate	Laboratory Testing.
Total Suspended Solids (TSS)	
Total Dissolved Solids (TDS)	

Parameter	Comments
Nitrogen (Total N, Ammonia N, Oxidised N, Organic N)	
Phosphorus (Total Phosphorus, Filterable reactive phosphorus)	
Surface Water: Analytes	
Nitrate	Laboratory Testing.
Sodium	
Aluminium	
Arsenic	
Barium	
Boron	
Cadmium	
Chromium	
Cobalt	
Copper	
Fluoride	
Lead	
Manganese	
Mercury	
Molybdenum	
Nickel	
Selenium	
Uranium	
Zinc	
Petroleum hydrocarbons (C6 - C9)	
Petroleum hydrocarbons (C10 - C36)	

6.4 Monitoring During Controlled Releases of Mine Affected Water

The release of mine affected water must only occur from RP1 into Hat Creek. In accordance with the EA, the release of mine affected water from RP 1 must:

- Only take place during periods of natural flow events in accordance with the receiving water flow criteria specified in Table 6.3.
- Not exceed the release limits specified in Table 6.4 when measured at RP1.
- Be undertaken so as not to cause:
  - Erosion of the bed and banks of the receiving waters.
  - A material build-up of sediment in such waters.
  - Visible discolouration of receiving waters; and
  - 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.

During releases of mine affected water, water quality must be measured at RP1, and at each of the upstream and downstream monitoring points specified in Table 6.1, for each quality characteristic and at the frequency specified in Table 6.4 and Table 6.5. Additionally, the daily quantity of mine affected water released into Hat Creek must be measured at RP1.

A 'Controlled Mine Water Release Procedure' will be developed during operations to ensure compliance with the EA conditions.

TABLE 6.3: MINE AFFECTED WATER RELEASE DURING FLOW EVENTS (TABLE C4 FROM THE EA)

Gauging Station	Northing (GDA20)	Easting (GDA20)	Receiving Water Flow Criteria (m^3/s)[1]	Maximum Permissible Release Rate (m^3/s)	Maximum Permissible Release Electrical Conductivity (µS/cm)[2]
MP 1	7587216	617623	>0.5	0.05	720
			>1	0.1	250
MP 3	7587196	620310	>0.5	0.05	720
			>1	0.1	250

[1]Flow triggers should be compared to natural flow only.
[2]Prior to release commencement, an assessment of the water quality in the relevant mine affected water storage 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.

TABLE 6.4: CONTAMINANT RELEASE LIMITS (TABLE C2 FROM THE EA)

Quality Characteristic	Release Limit	Monitoring Frequency at RP1	Monitoring Frequency at Upstream and Downstream Monitoring Points
Electrical Conductivity (µS/cm)	720 (baseflow) 250 (high flow)	Daily during release (the first sample must be taken within two (2) hours of commencement of release).	Daily during release.
pH (pH unit)	6.5 (minimum) 8.5 (maximum)		
Turbidity (NTU)	50		
Total Suspended Solids (mg/L)	55		Daily during release.

Quality Characteristic	Release Limit	Monitoring Frequency at RP1	Monitoring Frequency at Upstream and Downstream Monitoring Points
Sulphate (mg/L)	25	At commencement and prior to cessation of release (at a minimum) and weekly during a release[1]	

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

TABLE 6.5: RELEASE CONTAMINANT TRIGGER INVESTIGATION LEVELS (TABLE C3 FROM THE EA)

Quality Characteristic	Trigger Level[1, 2]	Monitoring Frequency at RP1
Total Suspended Solids	55 mg/L	Commencement of release and thereafter weekly during release.
Total Dissolved Solids	4000 mg/L	
Sulfate	<25 mg/L	
Aluminium	55 µg/L	
Arsenic (As V)	13 µg/L	
Boron	940 µg/L	
Cadmium	0.2 µg/L	
Fluoride	2000 µg/L	
Lead	3.4 µg/L	
Manganese	1900 µg/L	
Mercury (Inorganic)	0.06 µg/L	
Molybdenum	150 µg/L	
Nickel	11 µg/L	
Chromium	1.0 µg/L	
Copper	1.4 µg/L	
Zinc	8 µg/L	
Selenium	5 µg/L	
Uranium	0.5 µg/L	
Nitrate	400 mg/L	

Quality Characteristic	Trigger Level[1, 2]	Monitoring Frequency at RP1
Silver	0.05 µg/L	
Petroleum hydrocarbons (C6-C9)	20 µg/L	
Petroleum hydrocarbons (C10 – C36)	100 µg/L	
Sodium	180 mg/L	
Barium	2000 µg/L	

[1]All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metals/metalloids apply if dissolved results exceed trigger.
[2]The quality characteristics required to be monitored can be reviewed once the results of two 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 by amendment.

The trigger investigation levels specified in Table 6.5 must be reviewed within two 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 be collected at each site over at least 12 months (but 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 14 days. At this stage of operations at Broadmeadow East there is insufficient data to establish any trends.

6.4.1 Release Limit and Trigger Level Exceedances

If any of the trigger levels specified in Table 6.4 are exceeded for any quality characteristic at RP1 during a release event, the water quality at the downstream monitoring points must be compared to the trigger investigation levels specified in Table 6.5. If the downstream water quality does not exceed the trigger investigation levels, no action is required to be taken.

If the downstream water quality exceeds the trigger investigation levels (for any quality characteristic), the downstream water quality must be compared to the upstream water quality. If the downstream water quality does not exceed the upstream water quality, no action is required to be taken.

If the downstream water quality exceeds the upstream water quality (for any quality characteristic), the administering authority must be notified (via WaTERS) within 24 hours of receiving the result. Then, an investigation into the potential for environmental harm must be undertaken. A written report detailing the investigation and any actions taken prevent environmental harm must be provided to the administering authority within 90 days of receiving the result.

6.5 Water Storage Monitoring

Under the EA, the volume and quality of water in MWD1 and the North Pit must be monitored in accordance with Table 6.6.

TABLE 6.6: WATER STORAGE MONITORING (TABLE C7 IN THE EA)

Water Storage Description	Northing (GDA20)	Easting (GDA20)	Monitoring Location	Frequency of Monitoring
Mine Water Dam 1 (MDW1)	7586983	619068	Dam wall	Quarterly
North Pit	7587202	619379	Dam wall	Quarterly

6.6 Field Methodologies

Surface water monitoring should be undertaken in accordance with the Surface Water Monitoring Procedure, once it has been developed. When undertaking water sampling in the field, the following matters should be considered:

- **Monitoring equipment** – Equipment that may be required to conduct water sampling in the field includes hand-held probes, bottles and containers (ideally supplied by the laboratory), ice or ice bricks, and consumables such as syringes, filters, bubble wrap, extra bottles and containers for quality control samples and distilled water, GPS, camera, field sheets and Chain of Custody (COC) documents.
- **Equipment calibration** – Prior to sampling, hand-held probes should be calibrated using standards in the range of values expected to be encountered in the field. Electrical conductivity should be calibrated for fresh waters.
- **Gauging stations** – Gauging stations will be installed at GS 1 and GS 2 along Hat Creek to provide continuous measurements of streamflow to inform the baseline water monitoring dataset and identify controlled release opportunities.
- **In situ field water quality** – A calibrated hand-held probe should be used to measure in situ parameters (e.g., pH).
- **Sample preservation and holding times** – Before going into the field, ensure the preservation requirements and the maximum holding times for different parameters are known and can be met. The samples need to be delivered before the maximum holding times, with enough time for the laboratory to analyse the samples. If preservatives are to be taken into the field, they should preferably be supplied in small vials sealed in labelled plastic bags.
- **QA/QC –** The Queensland Water Quality Guidelines generally recommends one quality control sample is taken per sampling round to help ensure the monitoring program is robust and to verify the accuracy of collected data.
- **Field sheets** – Field sheets are to be used during sampling to record the time of sampling, the names, positions and roles of the people undertaking the sampling, in situ measurements, and any other general site information relevant to the sampling (e.g. weather conditions, vegetation disturbance, rubbish, scum, etc.). An example is provided in Appendix C:.
- **Chain of custody (COC)** – COC documents record information about a sample/s including date, time, sample identification (ID), sample matrix, preservation type, and analyses required. The COC document should be signed each time a person hands the sample to another person, and should include the full name and title of the person receiving the sample. Each laboratory has their own COC documentation which should be acquired prior to sampling. An example is provided in Appendix D:.
- **Labels** – Labelling of samples should be clear and consistent between sample rounds and written with a waterproof pen. The sampling sites should maintain consistent IDs to allow ease of data comparison and all sample labels should include the sampler initials, date and time. An example is provided in Appendix E.
- **Laboratory considerations and assessment of laboratory report** – Samples must be analysed at a laboratory accredited for the method of analysis being used (e.g., NATA). The assessment of the laboratory result must be performed by a suitably qualified and experienced person.

6.7 Emergency and Contingency Planning

If any surrounding surface water users indicate they have been adversely impacted as a result of the BME mining activities, an investigation will be undertaken, which may include:

- Identification of potential contributing factors including upstream influences.
- Assessment of surface water monitoring data, including stream flow data against background (upstream) trends to identify any anomalies or causes; and
- Where the impact is potentially attributable to the BME mining activities, appropriate make good provisions as well as mitigation and management strategies will be developed and implemented.

An Environmental Emergency Preparedness and Response Management Plan has been prepared for BME. Further detail on emergency and contingency measures, including references to site operating procedures and nominating responsible persons, will be developed as part of the next revision to this ESCP, after commencement of operations.

7. REPORTING AND REVIEW

7.1 Internal Reporting

Internal reporting of any erosion and sediment monitoring will be required during the operational phase of the mine, for example sediment dam levels and the results of ad hoc water quality sampling. Internal reporting procedures will be developed prior to or during the operational phase. At a minimum, all information related to erosion and sediment control monitoring (e.g., inspection templates, monitoring data, etc.) must be kept for a minimum of five years (Refer to Section 7.2).

7.2 External Reporting

The following external reporting is required by the EA:

7.2.1 Emergencies, Incidents and Exceptions

All reasonable actions must be taken to minimise environmental harm, or potential environmental harm, resulting from any emergency, incident or circumstances not in accordance with this SWMP or the EA.

The administering authority must be notified 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 the EA. The notification must be in written format at include, but not be limited to:

a) *"The holder the EA.*
b) *The location of the emergency or incident.*
c) *The number of the EA.*
d) *The name and telephone number of the designated contact person.*
e) *The time of the release.*
f) *The time the holder of the EA 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.*

Within 10 business days following the initial notification of an emergency or incident, or receipt of or 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.*

As soon as practicable, but not more than six weeks following the conduct of any environmental monitoring performed in relation to the emergency or incident, the results must be provided to the administering authority."

7.2.2 Controlled Releases of Mine Affected Water

Annual Water Monitoring Reporting

The following information must be recorded in relation to all water monitoring required under this SWMP and the conditions of the EA and submitted to the administering authority in the specified format with each annual return 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; and*

f) *The result of all monitoring and details of any exceedances of the conditions of this environmental authority.*

Water quality monitoring data must be provided to the administering authority via WaTERS.

Reporting Controlled Releases

The administering authority must be notified (via WaTERS) as soon as practicable but no later than 24 hours after commencing a release of mine affected water. The notification must include the following information:

a) *Release commencement date/time.*
b) *Details regarding the compliance of the release with the conditions of the EA (i.e. how EC, turbidity and pH compare to the trigger investigation levels and upstream water quality).*
c) *Release location (i.e. release point/s).*
d) *Release rate.*
e) *Release salinity.*
f) *Receiving water/s including flow rate when the release occurred.*
g) *Expected cessation date; and*
h) *Expected volume to be discharged.*

The administering authority must also be notified (via WaTERS) as soon as practicable but no later than 24 hours after the cessation of a release event. The notification must include the following information:

a) *Release cessation date/time.*
b) *Details of the receiving waters 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 releasee event.*

Note that successive or intermittent releases occurring within 24 hours of the cessation of any individual release can be considered part of a single release event and do not require individual notification.

Within 28 days of notifying the administering authority of the commencement of a release event, 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 waters including the natural flow rate; and*
    iv. *Volume of water released.*
b) *All in-situ and laboratory water quality monitoring results.*
c) *Details assessing compliance of the release with the EA (i.e. contamination limits, natural flow, discharge volume).*
d) *Whether the release resulted in any impacts to the receiving environment, and*
e) *Any other matters pertinent to the water release event.*

Reporting Release Limit Exceedances

If any of the release limits specified in Table 6.4 are exceeded during a release event, the administering authority must be notified (via WaTERS) within 24 hours of receiving the result.

a) *Within 28 days of the commencement of a non-compliant release event, a report must be provided to the administering authority (via WaTERS) detailing:*
b) *The reason for the release.*
c) *The location of the release.*
d) *The total volume of the release and which (if any) part of this volume was non-compliant.*
e) *The total duration of the release and which (if any) part of this period was non-compliant.*
f) *All water quality monitoring results (including all laboratory analyses).*

g) *Identification of any environmental harm as a result of the non-compliance.*

h) *All calculations; and*

i) *Any other matters pertinent to the water release event."*

7.3 Record Keeping

As mentioned in section 6, All information related to surface water monitoring (e.g., field sheets, calibration certificates, monitoring data, etc.) must be kept for a minimum of five years and be made available to the administering authority upon request.

Records should also be kept of revisions to this SWMP. Recommendations for future updates will be identified under the annual SWMP review (refer to Section 8.3).

7.4 Review and Modification

The BME EA outlines that the below documents related to water management are reviewed and/or updated:

7.4.1 Review Surface Water Management Plan

Under Condition C32 of the EA, the SWMP must be reviewed each calendar year and a report prepared by a suitably qualified and experienced professional. The plan must:

- Assess the plan against the requirements of Condition C31 of the EA.
- Include recommended actions to ensure actual and potential environmental impacts are effectively managed for the coming year; and
- Identified any updates to the plan following the review.

Key areas of this Water Management Plan that will require review and update for Surface Water Management components are likely include the below:

- Mine plan changes that impact surface water management.
- Identification of new water contamination sources and applicable control measures.
- Design details for water infrastructure post construction.
- Figures and corresponding tables; and
- Surface water quality data.

7.4.2 Review Erosion and Sediment Control Plan

Under condition C37 of the EA, the ESCP must be reviewed by an appropriately qualified person by March 1 for each Calendar year. The review must be documented and must:

- Include a statement that the Erosion and Sediment Control Plan has been reviewed by an appropriately qualified person;
- Assess the plan against the requirements of Condition C36;
- Include recommended actions to ensure actual and potential environmental impacts are effectively managed;
- Provide details and timelines of the actions to be taken; and
- Identify any amendments made to the Erosion and Sediment Control Plan.

Key areas of this Water Management Plan that will require review and update for Erosion and Sediment Control components are likely include the below:

- Mine plan changes that impact erosion and sediment control.
- Identification of new sediment affected sources/catchment areas and applicable control measures.
- Design details for water infrastructure post construction.
- Figures and corresponding tables

8. QUALIFICATIONS

b) In preparing this document, including all relevant calculation and modelling, Engeny Water Management (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.

c) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the site 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.

d) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

   i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or

   ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

e) Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the works, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works. All limitations of liability shall apply for the benefit of the employees, agents and representatives of Engeny to the same extent that they apply for the benefit of Engeny.

f) This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this plan.

g) If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon this plan or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.

h) This Plan does not provide legal advice.

9. REFERENCES

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APPENDIX A: WATER BALANCE

A.1 Site Water Balance Model

A site water balance model (WBM) was developed using GoldSim modelling software as part of the SWIA. This model has been designed to represent the water management system and surrounding waterways over the operational life of mine. The water balance model is based on local rainfall runoff modelling however does not incorporate interactions with the Hat Creek during flood events as the mine water management system is assumed to be protected by the flood protection levees. The site water balance model is used to calculate water volume as well as salinity using a mass balance approach. The model uses the Australian Water Balance Model (AWBM) to estimate rainfall runoff from climate data inputs.

The key model outputs used to assess the water management system include:

- Containment performance of key water storages.
- Pit inundation frequency, volume and period.
- Supply demands and shortfalls.
- Mine water release opportunities, and
- Changes to streamflow regime in surrounding waterways.

A schematic of the water management system is provided in Figure A.1. The water balance model replicates the transfer rates and destinations of the schematic.

The general water management system operating parameters for the model are described in Table A.1 below. Maximum operating volumes have been adopted to ensure no uncontrolled releases from storages occur in >95th percentile (i.e., extreme events).

TABLE A.1: WATER MANAGEMENT SYSTEM OPERATION FOR THE WBM

Storage	FSV (ML)	Max Operating Volume (ML)	Pump Destination/s	Adopted Pump Rate (L/s)	Years Active
North Pit	273	246	Dust Suppression	As required	Cessation of Mining
			Controlled Release to Hat Creek (only where maximum release rate is not reached for MWD1)	No controlled release scenario has been adopted for water balance simulation to represent the worst-case containment scenario	
South Pit	N/A	Operability Threshold =100	MWD1	100	From 2024
MWD1	20.4	12.2	North Pit	250	From 2024
			Dust Suppression	As required	From 2024
			Controlled Release to Hat Creek	No controlled release scenario has been adopted for water balance simulation to represent the worst-case containment scenario	

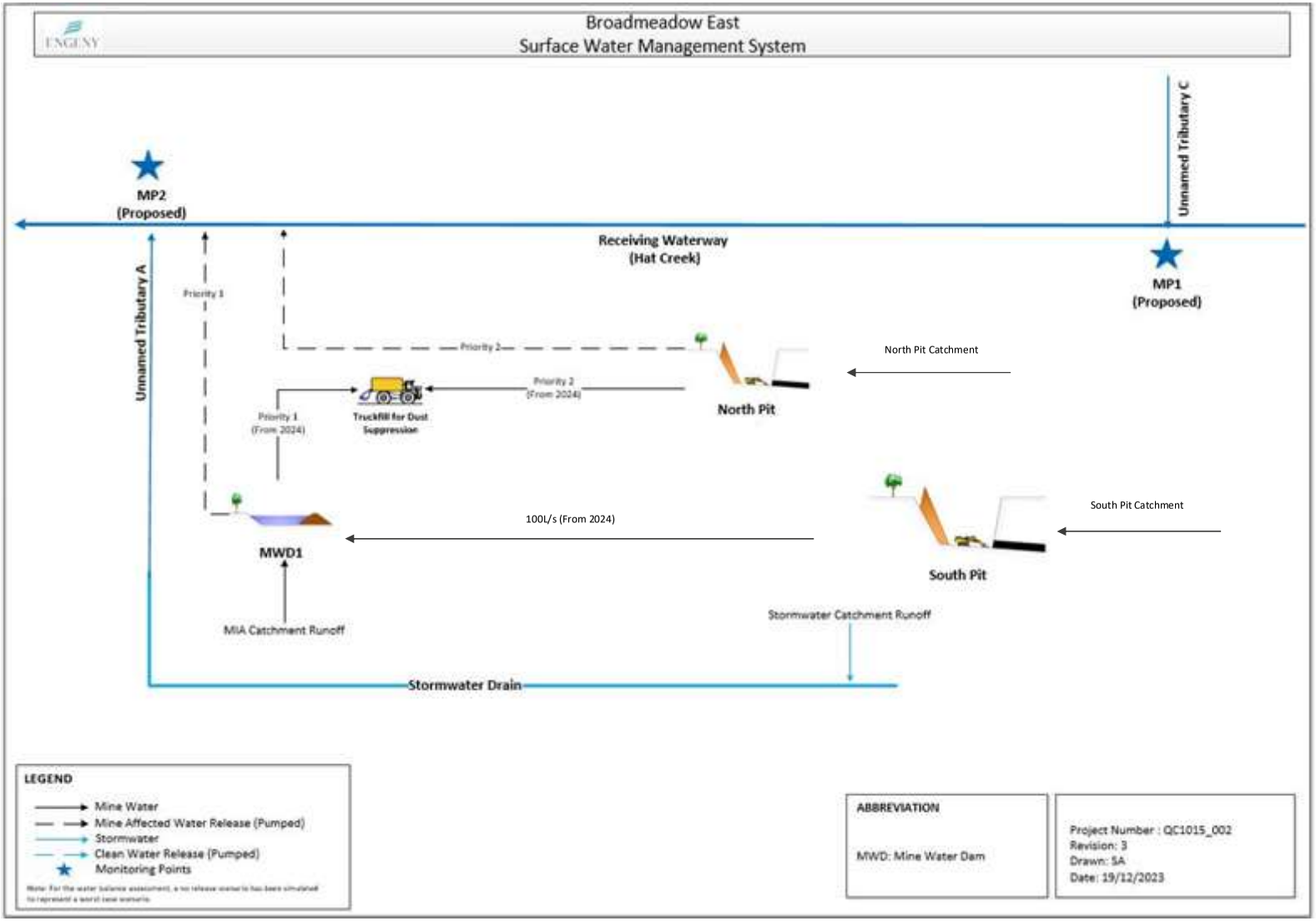


FIGURE A.1: BME WATER MANAGEMENT SCHEMATIC

A.1.1 Streamflow

Streamflow has been modelled for the pre-mining (baseline) scenario and the worst-case disturbance footprint during the life of mine to investigate streamflow impacts attributed to the proposed mining. The proposed downstream monitoring point (MP2) along Hat Creek was selected for the streamflow assessment as the streamflow impacts at this location will be conservative compared to further downstream (Refer to Figure 6.1).

A.1.2 Model Assumptions

A number of key assumptions were made during the model development process and are summarised in Table A.2.

TABLE A.2: KEY WBM ASSUMPTIONS

Input Parameter	Assumption, Justification and Data Source
Groundwater Inflow to Pits	Groundwater ingress curve delineated in Figure A.4. Based on numerical groundwater assessment undertaken by (KCB, 2021). Further discussed in GMMP.
Groundwater Quality	1000 mg/L (1500 µS/cm). Based on groundwater quality sampling data of Rangal Coal Measures (Nitro Solutions (now RPMGlobal), 2021). Refer to Section 5.3.
Pit Dewatering Pump Rates	South Pit = 100 L/s. Nominal pit dewatering rate.
Dust Suppression Demand	Calculated based on proposed internal road length and assumed width of 30 m (nominal width). Dust suppression demand is estimated based on daily evaporation rate when daily evaporation depth is higher than the daily rainfall depth. Refer to Section 5.6 for further details.
Release Criteria	No controlled release scenario has been adopted for water balance simulation to represent the worst-case containment scenario.
Pit Operability Sump Threshold	North Pit = 50 ML (when active). South Pit = 100 ML. Nominal sump capacity selected based on the full supply volume of 1.1 GL and 19.5 GL for North Pit and South Pit respectively.
Pit Operability Target	95% mean annual operability (optimal target).
MWD1 Storage Characteristics	Storage characteristics for the pit dewatering dam is constrained by surface area due to protected vegetation. The storage characteristics were determined based on topographic data provided.

A.1.3 Climate Data

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 133-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 A.3.

TABLE A.3: MONTHLY AVERAGE CLIMATE DATA USED FOR WBM

Month	Rainfall (mm)	Lake Evaporation (mm)	Evapotranspiration (mm)
January	112	196	234
February	100	164	192
March	71	165	197
April	31	132	165
May	27	102	137
June	30	81	115
July	23	92	128
August	19	119	159
September	15	152	197
October	29	189	240
November	51	199	247
December	84	208	254
Total	**591**	**1,800**	**2,266**

A.1.4 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 A.2.

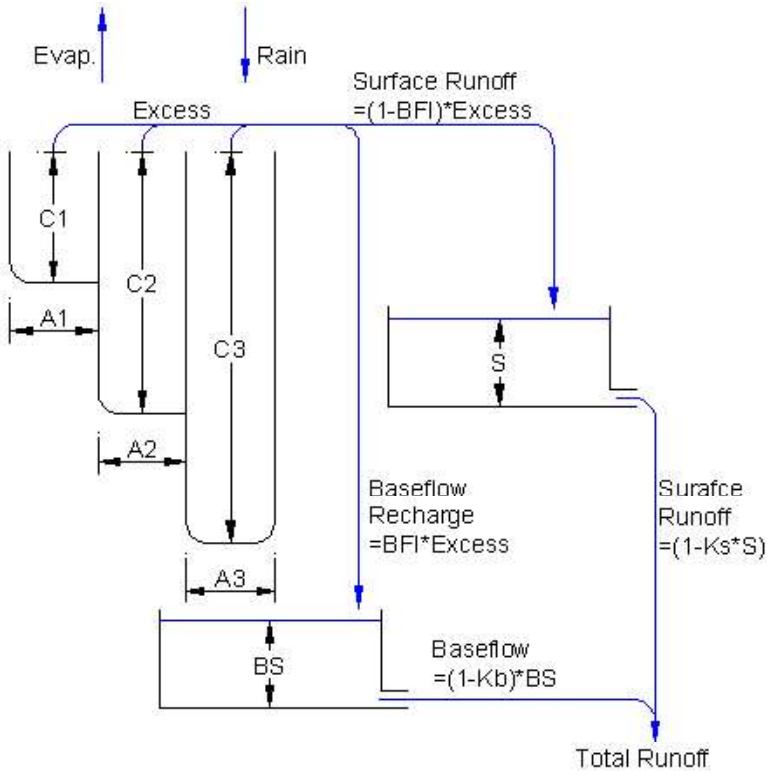


FIGURE A.2: AWBM SCHEMATIC

The adopted AWBM parameters are shown in Table A.4. In the absence of calibrated AWBM parameters for the BME mine location, 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. Due to the lack of stream flow gauging for the waterways surrounding BME, it was not possible to calibrate BME specific AWBM parameters, therefore the adopted parameters are consequently considered the most representative for water balance modelling for BME site.

As part of the proposed surface water monitoring program (Section 6) streamflow will be monitored on Hat Creek. 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 Surface Water Management Plan during operations.

TABLE A.4: AWBM PARAMETERS

Parameter	Natural	Waste Rehabilitation	Dump/Active	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

Parameter	Natural	Waste Rehabilitation	Dump/Active	Mining Pit/Hardstand	Rehabilitated Spoil
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	13.5%	13.9%		25.6%	11.3%

A.1.5 Catchment Runoff Water Quality

The BME 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 A.5.

TABLE A.5: SALINITY GENERATION RATES FOR LAND USE TYPES

Landuse 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).
Waste Rock Dump/ Active Rehabilitation	570	BME geochemical testing undertaken in February 2021.
Mining Pit/ Hardstand	1,370	
Rehabilitation Spoil	425	In absence of BME specific water quality data for rehabilitated landuse, the parameter has been sourced from the regional model that has been calibrated to the Isaac River.

A.1.6 Catchment Boundaries

Catchment areas were determined for all storages across the life of mine. Catchment boundaries were defined using the BCC provided topography data for 2024. The catchment breakdown to water storages and structures is show in Figure A.3 below. A summary of the site storage catchments is presented in Table A.6. Catchments reporting to storages are expected to remain unchanged in the near term based on advice from BCC.

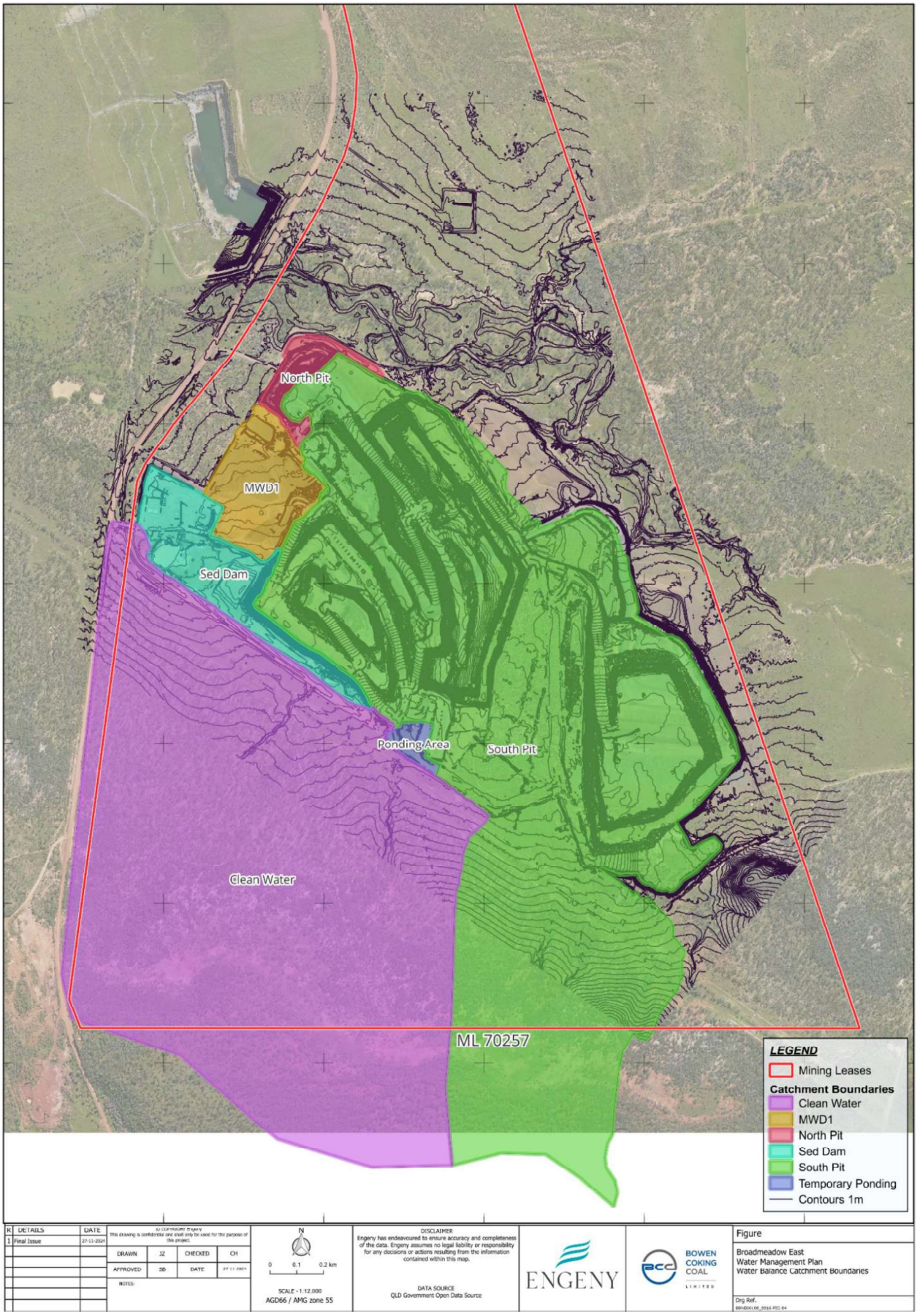


FIGURE A.3: BME SITE CATCHMENTS

TABLE A.6: TOTAL SITE STORAGE CATCHMENT AREA BY LAND USE

Land use	North Pit	South Pit	MWD1
Natural (ha)	0	88.1	0
Waste Rock Dump (Active Rehabilitation) (ha)	5.3	159.2	0
Hardstand and Pit (ha)	0	26.1	15.3
Total Area (ha)	5.3	273.4	15.3

A.1.7 Groundwater

Groundwater ingress to the North Pit and South Pit combined was provided as an input to the water balance model (KCB, 2021). Figure A.4 demonstrates that groundwater ingress is variable based on the geometry of the open cut pits i.e., groundwater ingress rate decreases with the increase in elevation. For the purpose of WBM, the groundwater inflow quality data is assumed as 1,500 µS/cm in accordance with the groundwater monitoring data summarised in the GMMP for the Rangal Coal Measures.

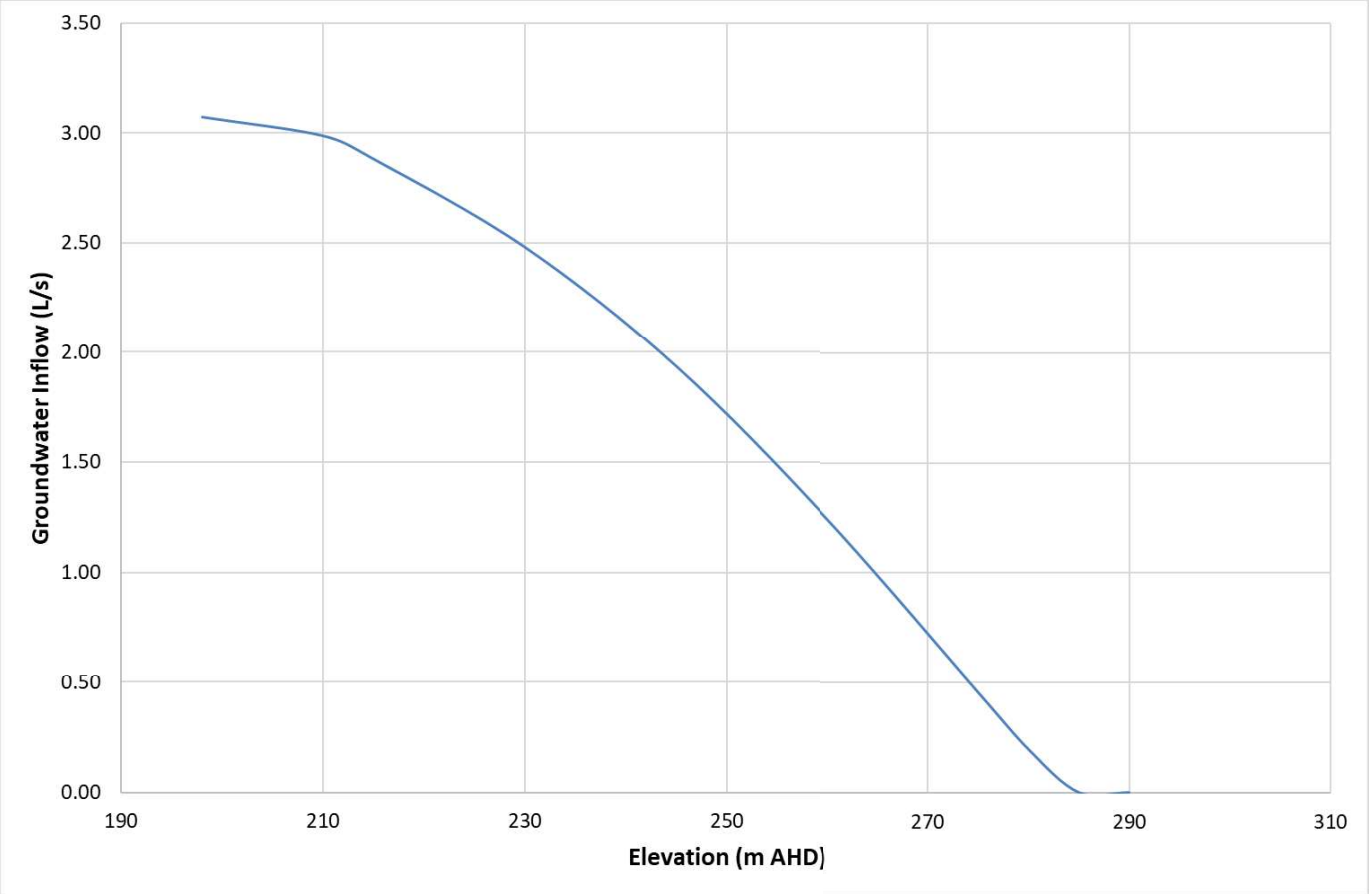


FIGURE A.4: NUMERICAL COMBINED GROUNDWATER INGRESS (KCB, 2021)

A.1.8 Starting Conditions

All storages have been modelled to commence at the beginning of the WBM simulation at zero percent capacity (empty). Sediment dams all start empty in compliance with their design basis. The sediment storage volume has not been included within the water balance model for sediment dams (i.e., only settling volume has been allowed for).

A.1.9 Simulation Details

The GoldSim model was run with a daily timestep as a probabilistic simulation for a period of 4 years, for the operational life of the mine. The model was simulated for 133 realisations stepping through 4-year sequences of the 133 years of available climate data for the mine site (1889 to 2020). The first model simulation realisation uses climate data from 1889 to 1893, the second realisation uses climate data from 1890 to 1894 and so on. Climate data was not "wrapped" to allow for additional realisations because the interannual climate patterns captured by running a simulation for an extended period of time cannot be accurately modelled using non-consecutive climate years. The WBM has been simulated to consider a minimum required operational performance target with a nominal sump capacity adopted for each operating pit as shown in Table A1-1.

For the streamflow analysis at MP2 the WBM simulation was simulated for post mining conditions (beyond 2027). The streamflow impacts are not expected to change throughout the life of mine given the minimal changes in catchments.

A.1.10 Water Balance Model Outcomes

The BME average annual water balance (inflows and outflows) for the life of mine is summarised in Table A.7 and shown in Figure A.5. The key outcomes from the average annual water balance include:

- Given minimal change in total catchment area reporting to storages between 2024 to 2027, rainfall and runoff inflow volumes stay relatively consistent.
- Surface water runoff and groundwater ingress account for on average 70% and 16% respectively of total water inflows to the system.
- Mine affected water accumulation is managed through use of North Pit as a mine water storage and through use of mine affected water for dust suppression.
- Dust suppression accounts for the largest outflow from the system (i.e., on average 42% of total outflows). Dust suppression demands are highest in 2026.
- Overall it can be seen there is a minor modelled accumulation of water within the BME water management system each year on average.

TABLE A.7: AVERAGE ANNUAL WATER BALANCE (ML/YEAR)

Inflow / Outflow	2024	2025	2026	2027
Rainfall	49	51	53	55
Rainfall runoff to mine water and sediment dams	269	280	278	282
Groundwater inflow to mining pit	75	83	82	80
Total Inflows	**393**	**414**	**412**	**417**
Evaporation	73	79	84	90
Dust Suppression	152	179	218	181
Controlled Release	0	0	0	0

Inflow / Outflow	2024	2025	2026	2027
Total Outflows	224	259	302	271
Net Balance	74	29	-14	19

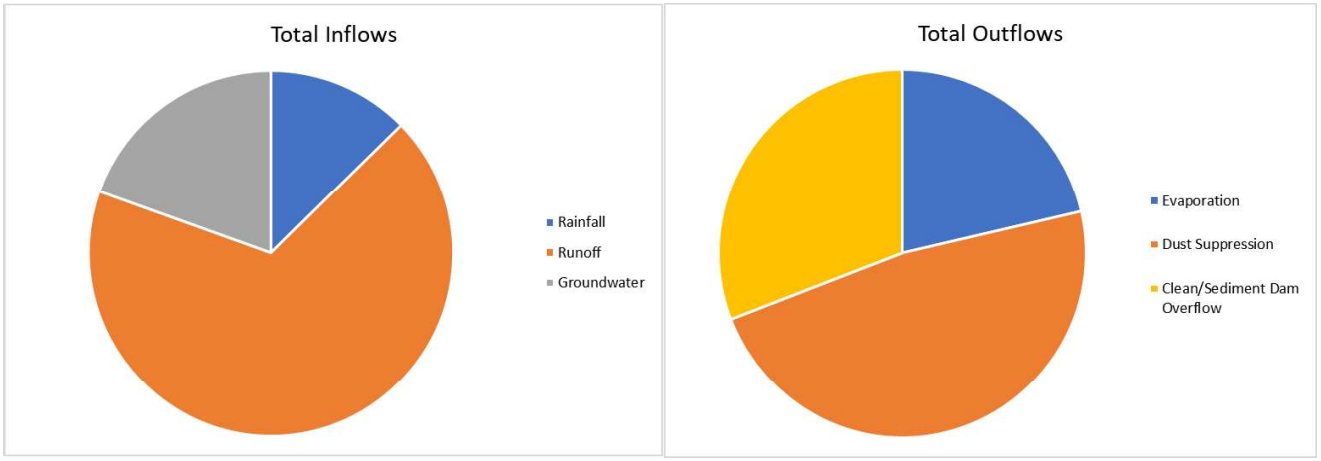


FIGURE A.5: TOTAL AVERAGE INFLOWS/ OUTFLOWS FOR THE BME MINE

A.1.11 Site Water Inventory

Modelled total mine water inventory on site and individual modelled inventory for Mine Water Dam 1, North Pit, and South Pit are presented in Figure A.1, Figure A.7, Figure A.8 and Figure A.9 respectively for the BME mining duration. The site has a modelled maximum stored inventory of approximately 1120ML in the >99th percentile (i.e., statistically very wet years). During these periods, it may be necessary to use South Pit as an emergency water storage to mitigate against uncontrolled releases.

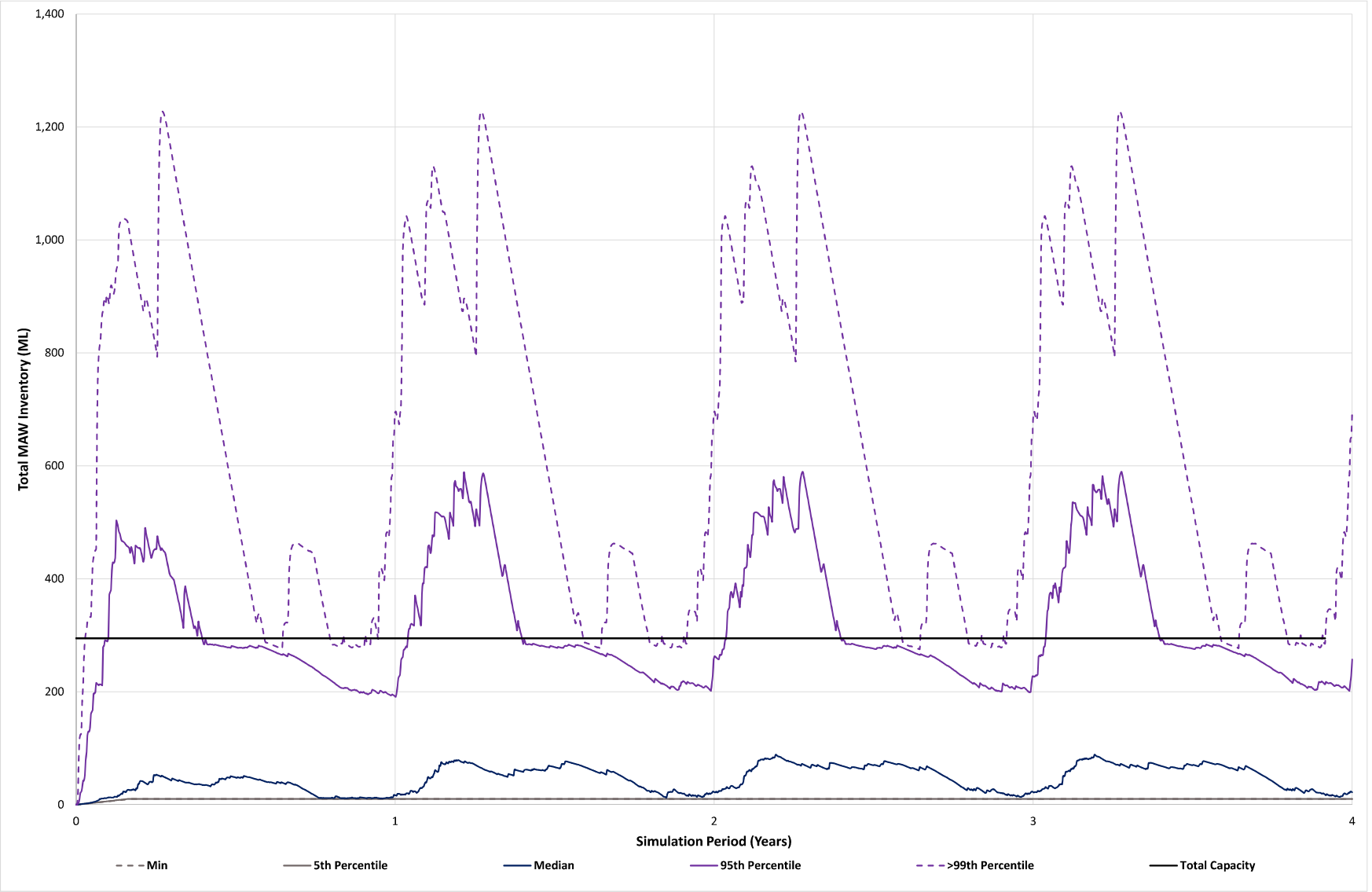


FIGURE A.6: MODELLED TOTAL SITE MINE AFFECTED WATER (MAW) INVENTORY

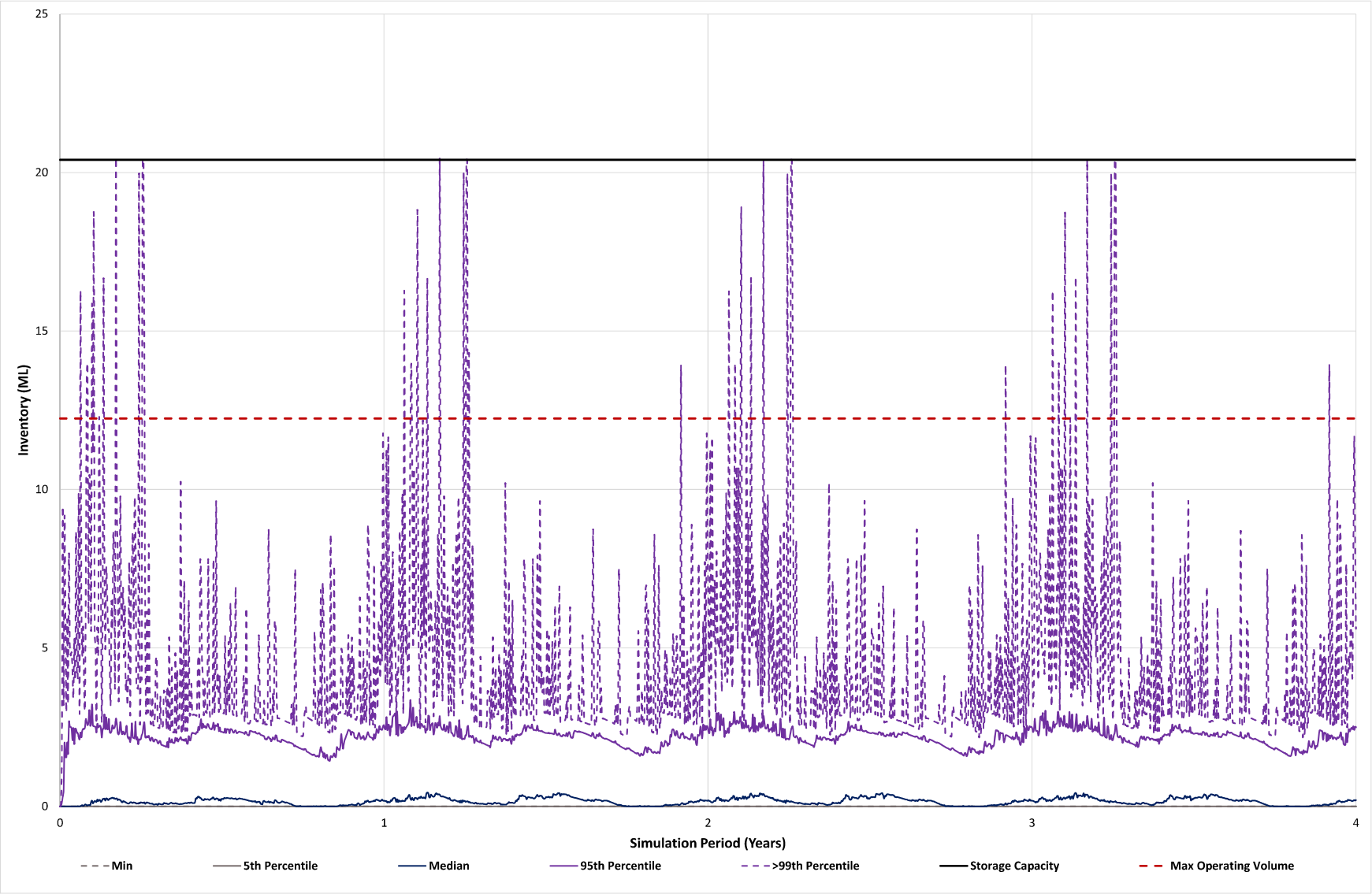


FIGURE A.7: MODELLED MWD1 INVENTORY

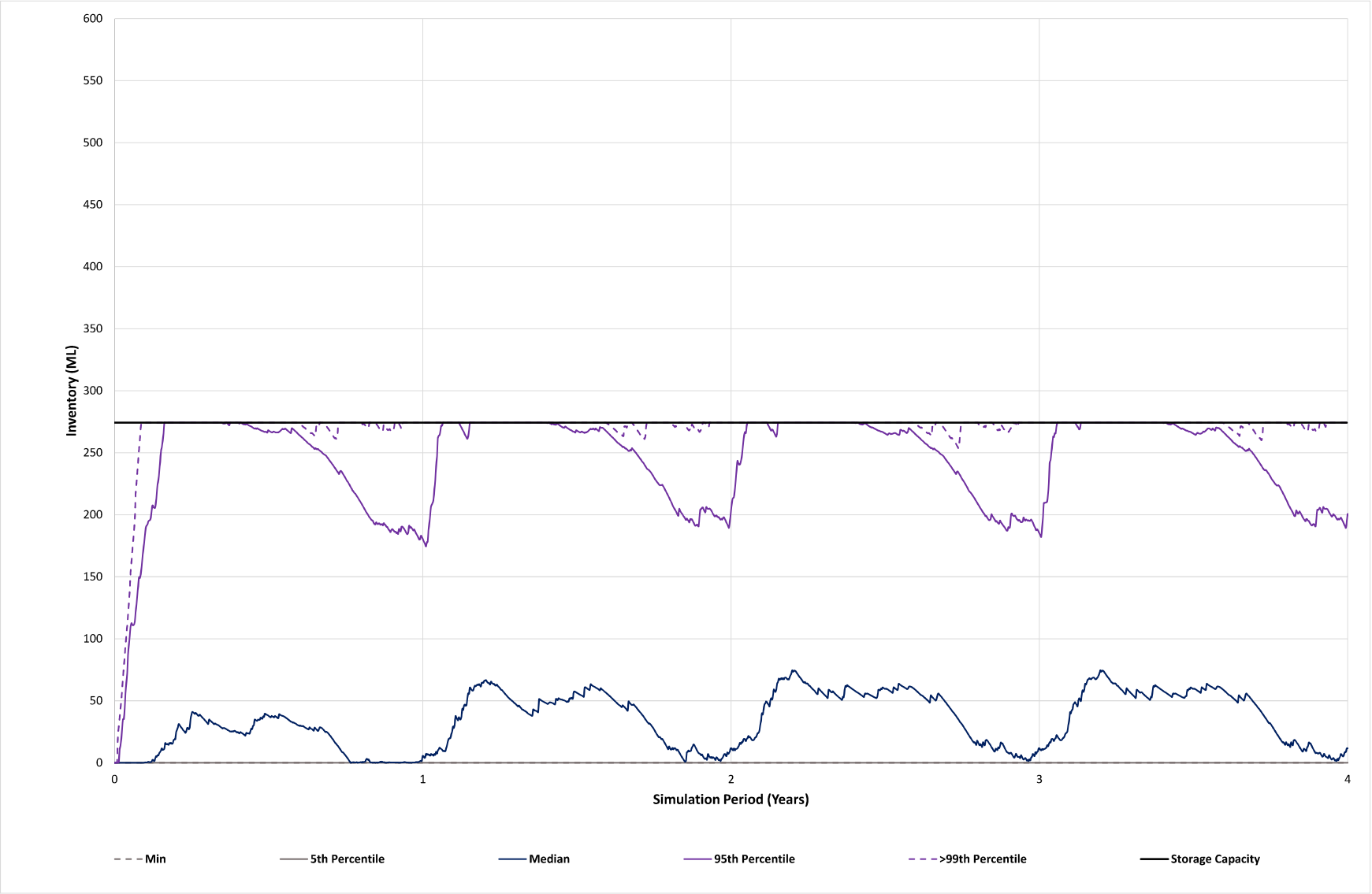


FIGURE A.8: MODELLED NORTH PIT INVENTORY

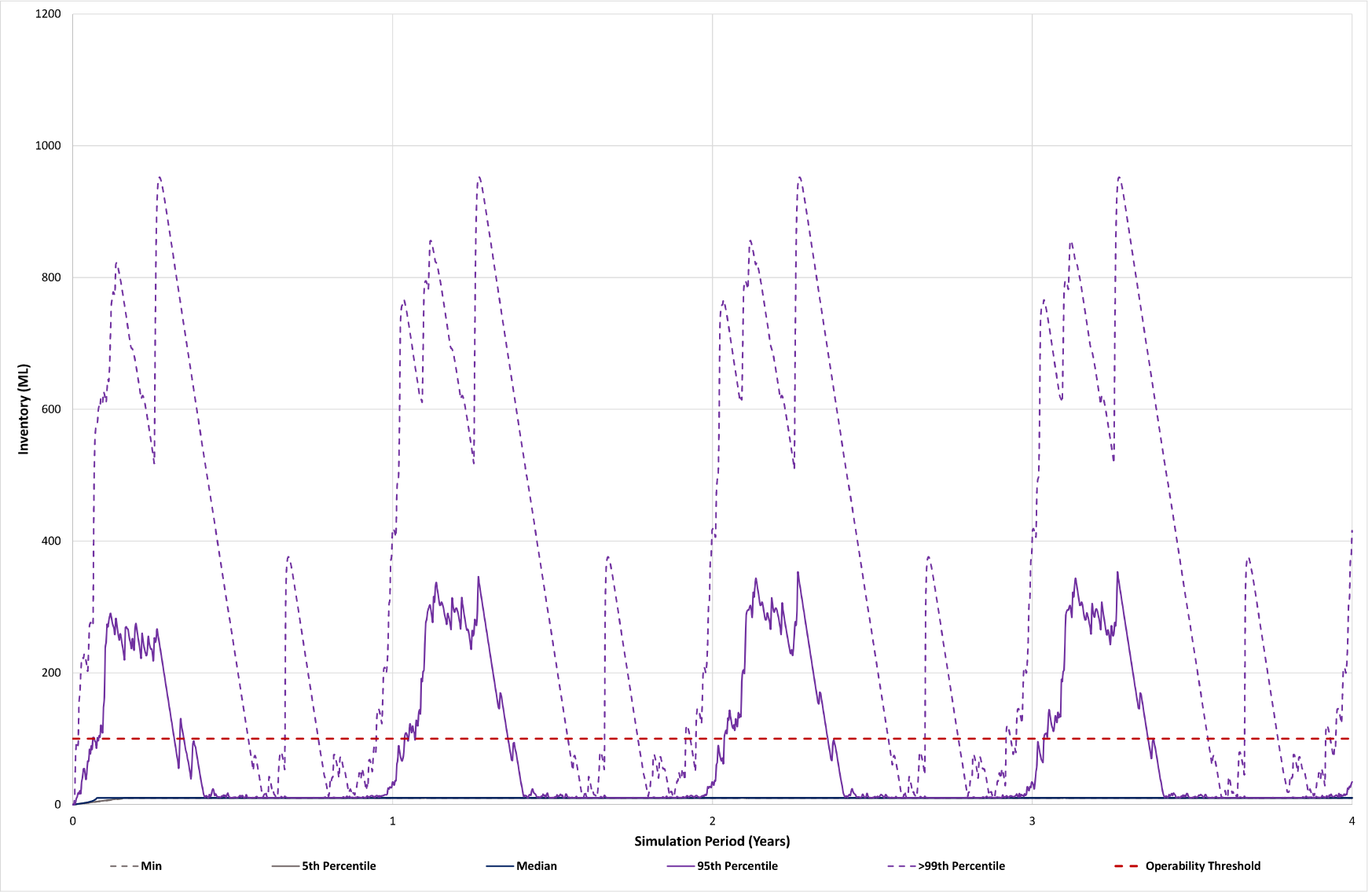


FIGURE A.9: MODELLED SOUTH PIT INVENTORY (ACTIVE MINING PHASE)

The WBM results achieved the desired pit operability requirements. The modelled average number of days per year that water within, the active mining pit, South Pit exceeds the pit sump capacity during the active mining period is summarised in Table A.8. The results indicate 95% operational reliability throughout the life of mine.

TABLE A.8: AVERAGE ANNUAL PIT INUNDATION DAYS OF ACTIVE MINING PIT

Year	South Pit
1	10 days
2	15 days
3	15 days
4	17 days

A.1.12 Controlled Mine Water Releases

Controlled mine water releases were not modelled to represent a conservative scenario. Therefore there are no modelled controled releases from MWD1 or North Pit.

A.1.13 Uncontrolled Releases

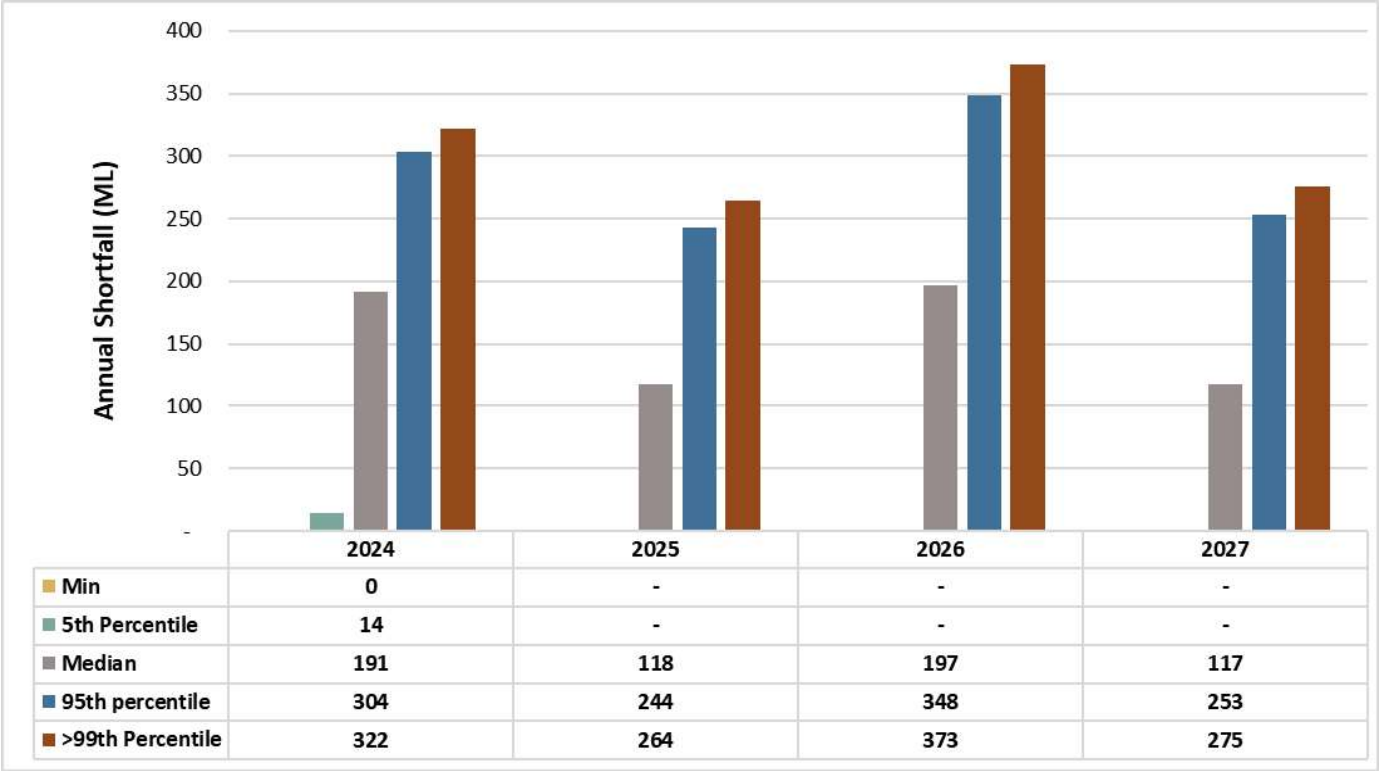
The MWD1 and North Pit were modelled to have no uncontrolled overflows during the life of mine under all climate scenarios. Mine affected water accumulation is managed through the flexible mine water management system including use of temporary storage within the South Pit via box cut ahead of the mine plan if required.

Sediment dams were designed to contain an 85th percentile 5-day rainfall event based on guidance from the Best Practice Erosion and Sediment Control Guidelines (IECA, 2018). Stored water within sediment dams will be opportunistically used for supplying dust suppression demands, however passive overflows will occur during rain events larger than the design capacity of the structures.

A.1.14 Dust Suppression Demands and Shortfall

The modelled dust suppression shortfall throughout the life of the BME Project is shown in Figure A.10 for a range of probabilities. The results show dust suppression demand shortfalls across all years in median conditions with shortfalls most likely within 2026 due to this period having the highest dust suppression demand.

It should be noted that modelled shortfalls are dependent on the assumed dust suppression rates and could be revised if actual site water use for dust suppression is recorded. Third-party commercial agreement for supplementary external supply of water is a potential option to support the Project's operational dust suppression demand requirements but is subject to engagement and approval processes.



	2024	2025	2026	2027
Min	0	-	-	-
5th Percentile	14	-	-	-
Median	191	118	197	117
95th percentile	304	244	348	253
>99th Percentile	322	264	373	275

FIGURE A.10: MODELLED ANNUAL DUST SUPPRESSION DEMAND SHORTFALL

A.1.15 Streamflow

Streamflow impacts were modelled for post mining conditions (following 2027) at the proposed downstream monitoring point (MP2). No other years were modelled given minimal changes in catchment areas reporting to storages and therefore minimal reduction in catchment area reporting to Hat Creek.

Table A.9 outlines the modelled changes to the flow regime of Hat Creek at MP2 and are summarised below:

- The flow duration curve (Figure A.11) compares the modelled baseline stream flow against the modelled streamflow post-mining. It can be seen even in the baseline (pre-mine) case there is negligible or no flow in Hat Creek at MP2 for approximately 77% of days. The results indicated up to a one-day reduction in the average annual number of flow days per year (77 days/year) in comparison to baseline (78 days/year).
- 7% reductions in volume at MP2 based on mean annual and median annual flow volumes respectively.

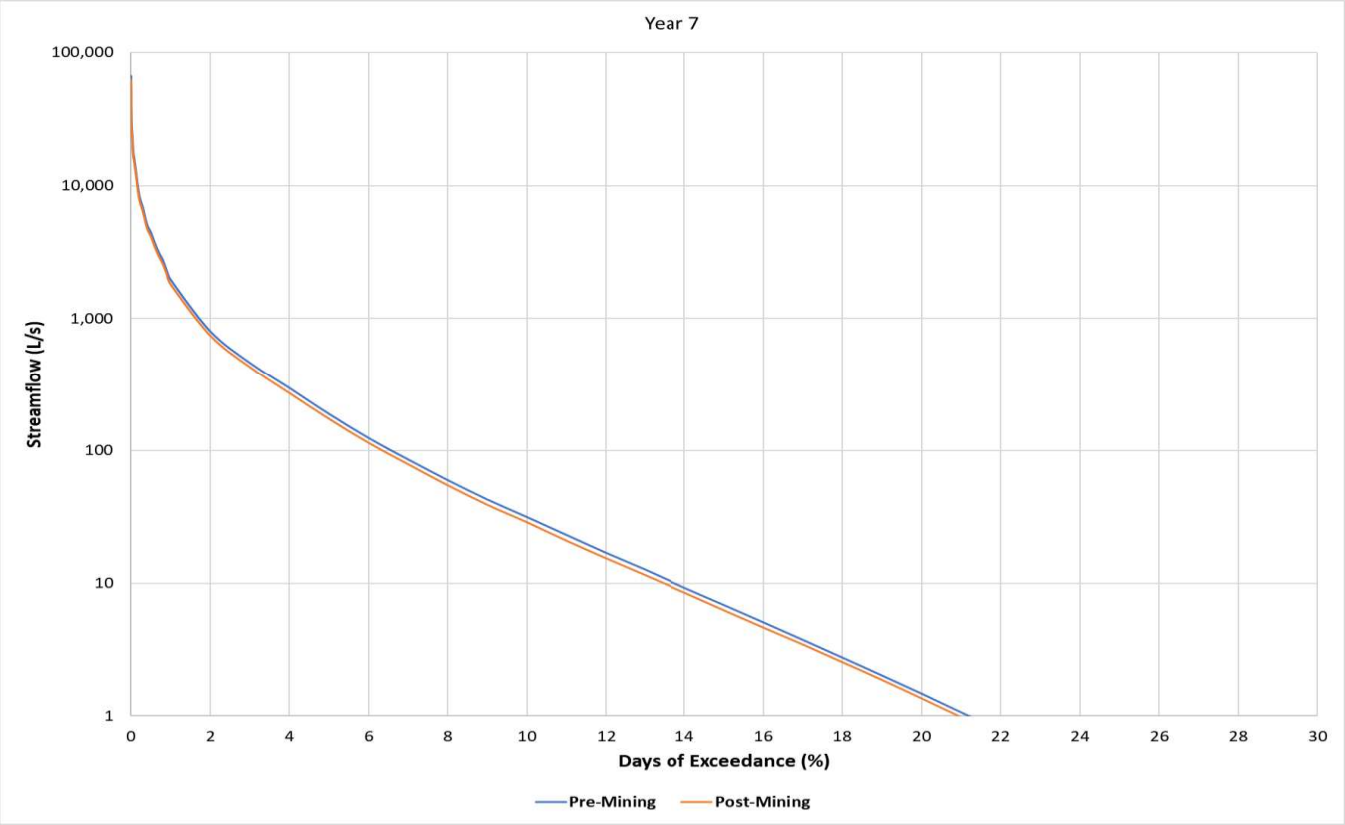


FIGURE A.11: OPERATIONAL FLOW DURATION CURVE COMPARISON AT MP2

TABLE A.9: VOLUMETRIC STREAMFLOW COMPARISON

Statistic	Mean	Median
Pre-mining streamflow (ML)	3,050	1,713
Post-mining streamflow (ML)	2,823	1,596
Reduction in volume (%)	7%	7%

APPENDIX B: FIELD SHEET TEMPLATE

Water Quality Sampling Field Data Sheet

Name:	
Date:	
Start Time:	
End Time:	
QA/QC Check:	

Sample ID	Location	Time Sampled	pH (pH units)	Electrical Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Comments

Sampling for lab analysis required?	Yes/No (If yes, fill out Chain of Custody form for delivery of samples to laboratory)
Signature:	

APPENDIX C: COC TEMPLATE

Sample Chain of Custody Form

ALS Minerals

This form is used to assure Chain of Custody during transfer of samples from a client to ALS Minerals, based on the number of items shipped.

This shipment consists of the following (Enter number of items):

_____ Super Sacks

_____ Zip-tied Rice Bags

_____ Bins – Locked/Covered/Uncovered

_____ Color identification: number, letter, etc.

_____ Pallets

_____ Paperwork Included (please specify): SSF/Client COC, etc.

_____ Other: Boxes/Bags

Comments _____

_____

_____

_____

Internal Use Only

Company Name: _____

Client Code: _____

Project/Location: _____

Courier Name and Waybill number if applicable: _____

Security Tag Numbers if applicable: _____

Released By:

Company Representative: _____ Date & Time: _____
(Please Print)

Client Signature: _____

Internal Use Only

ALS Minerals

Received By ALS Minerals Staff Name: _____(Please Print)

ALS Staff Signature: _____ Date & Time: _____

*All shipments received are subject to inspection upon layout; all services are rendered in accordance with ALS Minerals Terms & Conditions (see the current Schedule of Services & Fees).

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11/30/2012

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

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☐BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com
☐MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com
☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
☐MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com
☐NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com
☐NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com
☐PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
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☐WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT:	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**
OFFICE:		☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes No N/A
PROJECT:	**ALS QUOTE NO.:**	**COC SEQUENCE NUMBER (Circle)**	Free Ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER:		COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER:	**CONTACT PH:**	OF: 1 2 3 4 5 6 7	Other comment:

SAMPLER:	**SAMPLER MOBILE:**	**RELINQUISHED BY:**	**RECEIVED BY:**	**RELINQUISHED BY:**	**RECEIVED BY:**
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**				
Email Reports to (will default to PM if no other addresses are listed):		DATE/TIME:	DATE/TIME:	DATE/TIME:	DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed):					

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL CONTAINERS									Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
				TOTAL										

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

APPENDIX D: LABELS FOR TRANSPORT TO LABORATORY

Labels for Transport to Laboratory

Labels are usually provided by the laboratory providers and must at least include:

Date:		Sample ID:	
Location:		Sample Time:	
Personnel:		Notes:	
Organisation:			
Sample Type:			

TECHNICAL MEMORANDUM

TO: Richard Oldham
Bianca Voges-Haug
Aislinn Macintyre

DATE: 21 June 2024

FROM: Marlese Nel

FILE NO: DX70025A07

SUBJECT: Final Revision and Update of Groundwater Triggers for BME to support EA Amendment in response to Request for Information

1 INTRODUCTION

KCB Australia Pty Ltd (KCB) has been requested by Bowen Coking Coal (BCC) to assist with the revision and update of some of the groundwater triggers in support of an Environmental Authority (EA) Amendment application.

This document provides a brief background, an overview of the revision approach, calculation of proposed groundwater triggers, and recommendations are made for assigning trigger limits to new replacement bores drilled in October 2023.

2 BACKGROUND

BCC operates the Broadmeadows East (BME) Project under EA EA0002465 (February 2, 2023). Conditions D1 to D18 of the EA relate to groundwater.

Table D1 and Table D2 of the EA presents the current groundwater water level and quality triggers. These triggers were calculated in February 2022 based on data available at the time.

Condition D2 of the EA refers to the baseline groundwater monitoring program and in terms of triggers specifically states:

> *"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;"*

The purpose of this memorandum is to comply with condition D2 in support of an EA Amendment to update the groundwater level and quality triggers for the BME monitoring bores and to make recommendations regarding triggers for newly drilled replacement monitoring bores. It also provides support to the exceedance investigation for MBBE0001.

During the 2023 groundwater monitoring reporting period an exceedance was recorded as per definition in Condition D7:

> *"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".*

Compliance bore MBBE0001 recorded an exceedance for Electrical Conductivity (EC) and as per EA requirements a notification was made vis WaTERS and a subsequent investigation performed and submitted to DES within the required timeframe.

3 HYDROGEOLOGICAL CONCEPTUAL SUMMARY

3.1 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 was sourced from the Scientific Information for Landowners database (SILO) at the Wentworth Station, located close to the Project area.

The rainfall data was analysed to produce a cumulative rainfall departure (CRD) trend (Figure 3.1). 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.

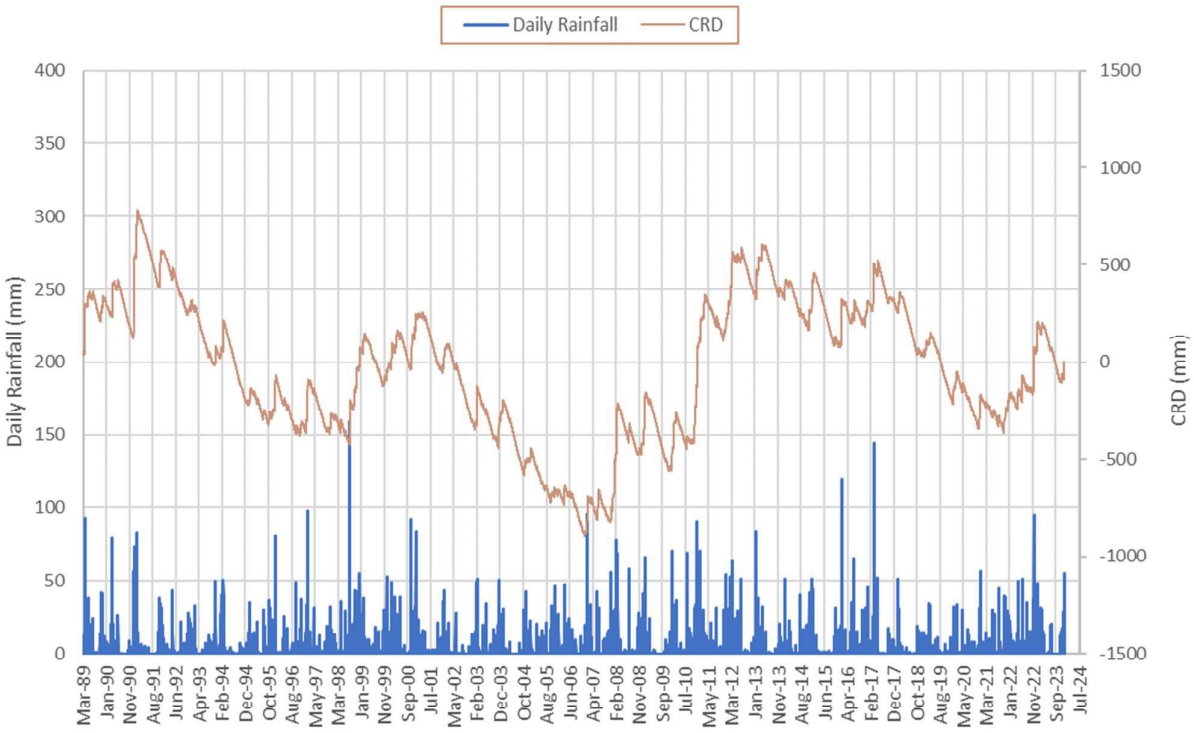


Figure 3.1 Daily rainfall and CRD, January 1989 to December 2023, Wentworth Station (SILO)

Key climatic trends observed in the period from the CRD trend are:

- 2002 to 2007: A 6-year decreasing trend, where below average rainfall occurred.
- 2007 to 2010: A 4-year increasing trend, but rainfall still below average.

- 2010 to 2019: A 10-year above average rainfall period, including some large rainfall events.
- 2019 to 2022: A 4-year below average rainfall period.
- 2023 to present: A short period of above average rainfall.

The impact of seasonality, long term climatic trends and above average rainfall events could manifest in changes in groundwater quality and should be taken into consideration when evaluating the groundwater chemistry.

3.2 Hydrostratigraphy

The following hydrostratigraphic units have been identified at BME:

- ***Quaternary Alluvium:*** a unit associated with the ephemeral watercourses in the Project area. The regional water table is typically located several metres below the base of the alluvium, which has a thickness ranging from 3 m to 4 m and is typically dry and unsaturated.
- ***Tertiary Sediments:*** a unit with a heterogenous profile of semi-consolidated quartz sandstone, clayey sandstone, mudstone and conglomerate, fluvial lacustrine sediments, and minor interbedded basalt. This unit is predominantly located to the south of the Project area and has a thickness of up to 15 m. As with the alluvium, these are typically located above the regional groundwater table and are therefore generally dry.
- ***Tertiary Basalt:*** a unit 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. The hydraulic properties of the basalt can vary considerably as groundwater is primarily stored within highly compartmentalised fractures and vesicular zones. Tertiary basalt was identified only in one bore in the southwest corner of the mining lease, where it is 15 m thick and dry.
- ***Triassic Rewan Group:*** a unit that is recognised as a regional aquitard and acts as a confining unit overlying the Permian sediments. The Rewan 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.
- ***Permian Coal Measures:*** a unit that comprises of alternating layers of fine to medium grained sandstone, siltstone and coal, including the target Leichhardt seam 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. Individual coal seams form the principal water bearing strata within the coal measures and are therefore typically saturated and the majority of the monitoring bores are screened within this unit.

The geology encountered, groundwater qualities and dissolved metal concentrations are not unexpected based on the geology of the site and dissolved metal concentrations in the groundwater are reflective of local geology and local pH.

3.3 Potential sources of groundwater quality impact

Processing and associated management of rejects from processing activities will be handled offsite at an existing facility. Therefore, the potential for contamination of the groundwater will be in relation to spills associated with hydrocarbon and chemical usage at the Project site. However, the storage of hydrocarbons and chemicals will be managed in accordance with standard management practices, including the use of bunding and the immediate clean-up of spill, which are typically legislated requirements at mine sites.

OOPD's (stockpiles and dumps) could impact the groundwater quality when leachate from the OOPDs' reaches the groundwater level. The hydrogeological environment on the site will determine how fast (based on hydraulic conductivity) and how far (extent of potential impact) this potential impact could occur.

4 GROUNDWATER MONITORING PROGRAM

4.1 Current EA monitoring bores

Condition D3 states that 'groundwater quality and levels must be monitored at the locations and frequencies defined in Table D1 – Groundwater monitoring locations and frequency'. Further requirements for groundwater quality monitoring and groundwater level monitoring are provided in Condition D4 and D5 respectively.

The current monitoring network as presented in Table D1 of the EA is summarised in Table 4.1.

Table 4.1 Groundwater Monitoring Locations and Frequency (Adapted from Table D1 of the EA February 2, 2023)

Monitoring ID	Easting (GDA20)	Northing (GDA20)	Monitoring Frequency
Compliance Bore			
MBBE0001	619884	7585428	▪ Quarterly measurements of SWLa ▪ Quarterly EC and pH ▪ Six-monthly for remaining analytes
MBBE0007	620615	7586415	
EA Monitoring Bore			
MBBE0002	618436	7585329	▪ Quarterly measurements of SWL ▪ Quarterly EC and pH ▪ Six-monthly for remaining analytes
MBBE0003	618431	7584664	
MBBE0004	620205	7586976	
MBBE0006	619173	7587205	
MBBE0008	620294	7585092	
BDW5C	619687	7586758	
BDW8C	619782	7585651	
BDW172(32)	619376	7586650	
BDW172(54)	619376	7586650	

a. SWL = Standing Water Level

Baseline monitoring data at BME is available for the EA monitoring bores for the time periods as summarised in Table 4.2.

Table 4.2 Baseline monitoring data time periods for EA bores

Monitoring ID	Monitoring period	
	From	To
BDW172(32)*	Aug-99	Feb-22
BDW172(54)*	Aug-99	Feb-22
BDW5C*	Jan-06	Sep-22
BDW8C*	Jan-06	Aug-23
MBBE0001**	Feb-21	2024
MBBE0002b	Feb-21	Current
MBBE0003	Feb-21	Current
MBBE0004	Feb-21	Current
MBBE0006*	Feb-21	Sep-23
MBBE0007	Apr-21	Current
MBE00008	Aug-21	Current

*mined through
**planned to be mined through

Some data gaps exist for BDW172(32), BDW172(54), BDW5C and BWD8C; before BCC took ownership of the mine in January 2021. Since then, monitoring has been recorded and reported as per the EA requirements.

Due to progression of mining operations, some of the existing EA monitoring bores have been mined through. Four (4) new replacement monitoring bores were therefore drilled in October 2023 to update the groundwater monitoring network.

The updated monitoring network locations are shown in Figure 4.5.

4.1.1 Groundwater Monitoring Results

MBBE0001

Groundwater quality data from February 2021 to February 2024 for compliance bore MBBE0001 indicates a slight increase in electrical conductivity (EC). The minimum and maximum over this period are 801 µS/cm and 947 µS/cm respectively.

The EC concentrations and the current water quality trigger limit are shown in Figure 4.1 and a summary of the results for analytes as listed in Table D2 of the EA for this bore is shown in Table 4.3 (values in exceedance of water quality trigger limit as stipulated in EA highlighted in **red**).

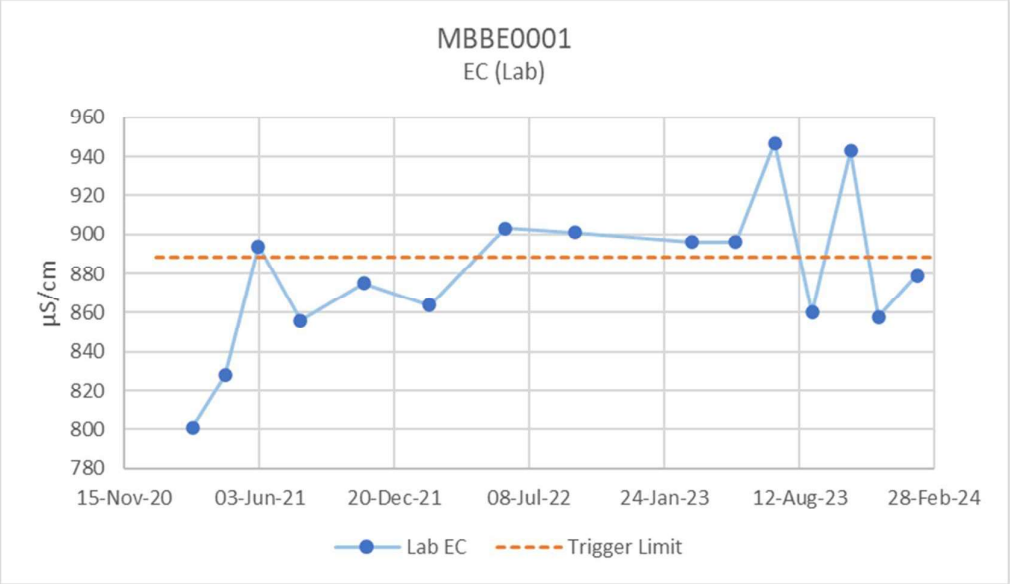
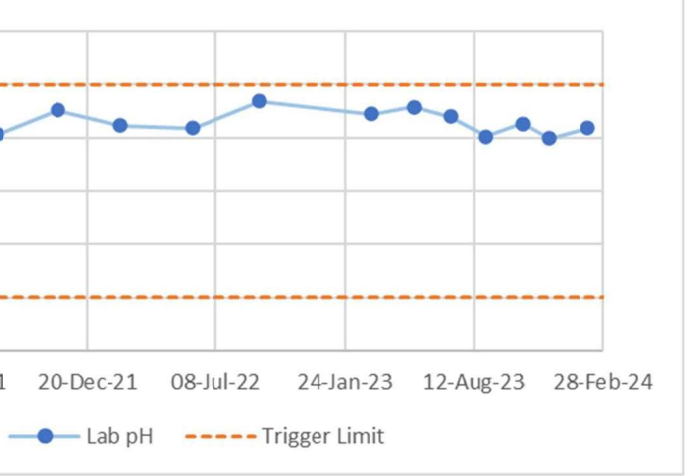


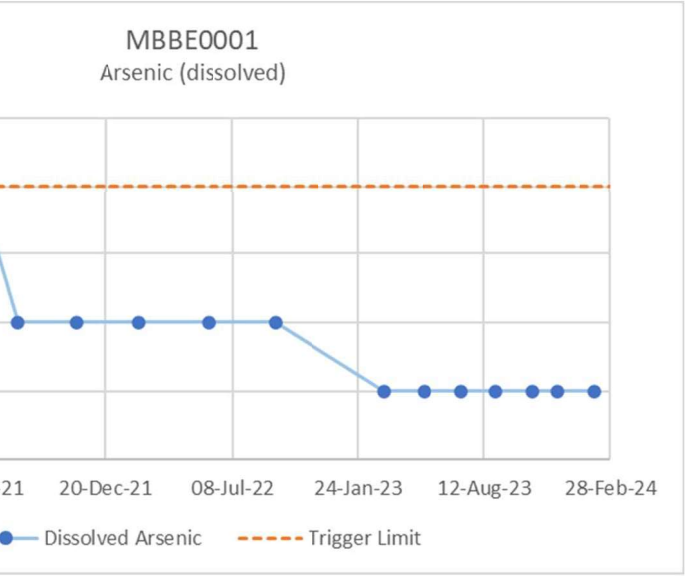
Figure 4.1 **Electrical conductivity (EC) for compliance bore MBBE0001 for total monitoring period**

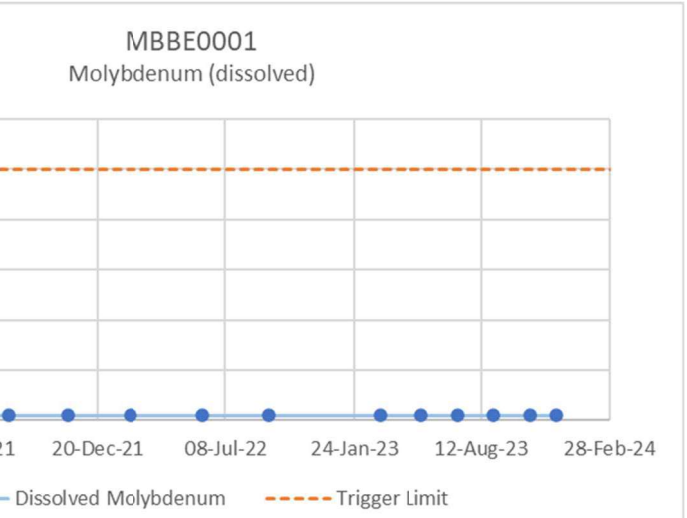
Table 4.3 Laboratory results for water quality triggers (as per Table D2 EA0002465) for MBBE0001 over monitoring period

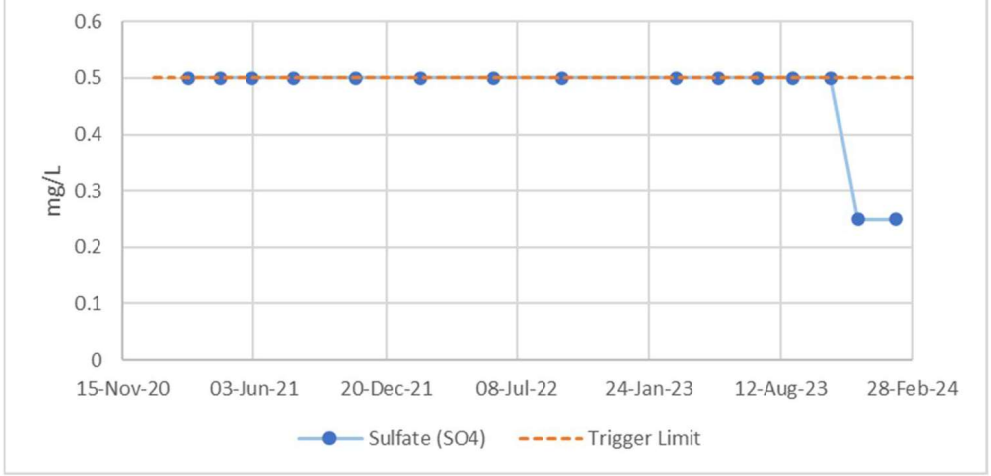
Trigger Parameter	Unit	MBBE0001														
		Feb 2021	April 2021	June 2021	Aug 2021	Nov 2021	Feb 2022	June 2022	Sept 2022	March 2023	May 2023	July 2023	Aug 2023	Oct 2023	Dec 2023	Feb 2024
pH	pH units	8.3	7.78	8.26	8.03	8.26	8.11	8.09	8.34	8.22	8.29	8.2	8.01	8.13	7.99	8.09
Electrical Conductivity	µs/cm	801	828	**894**	856	875	864	**903**	**901**	**896**	**896**	**947**	860	**943**	858	879
Sulfate	mg/L	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]	<1[1]
Arsenic	mg/L	<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
Aluminium	mg/L	0.07	0.08	0.08	0.06	0.04	0.03	0.03	0.01	<0.01	0.02	0.02	<0.01	0.02	<0.01	<0.01
Molybdenum	mg/L	<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
Selenium	mg/L	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	<0.01[1]	NR

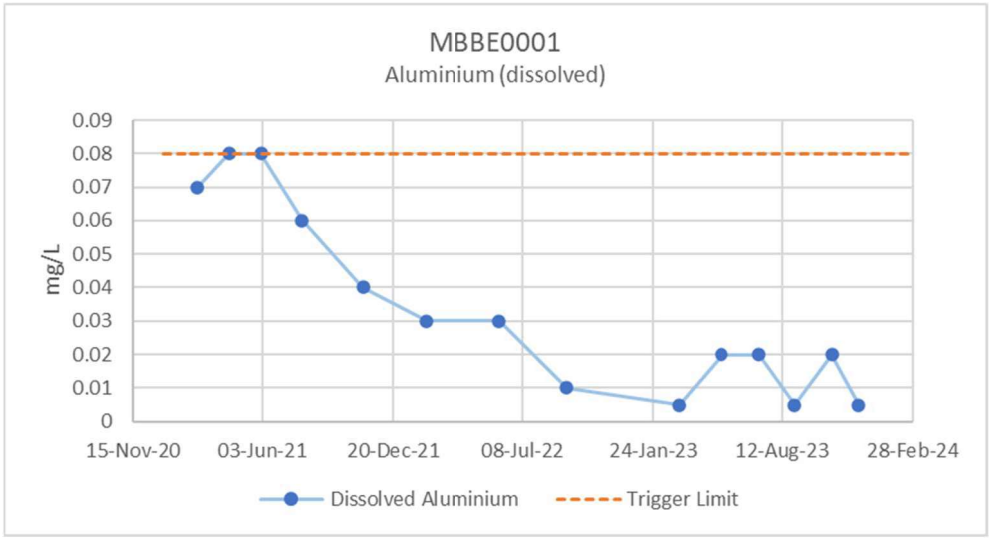
1. Note: where exceedances are at the limit of reporting of the lab, halving of the value results in less than or equal to the trigger value.
NR = No Resul

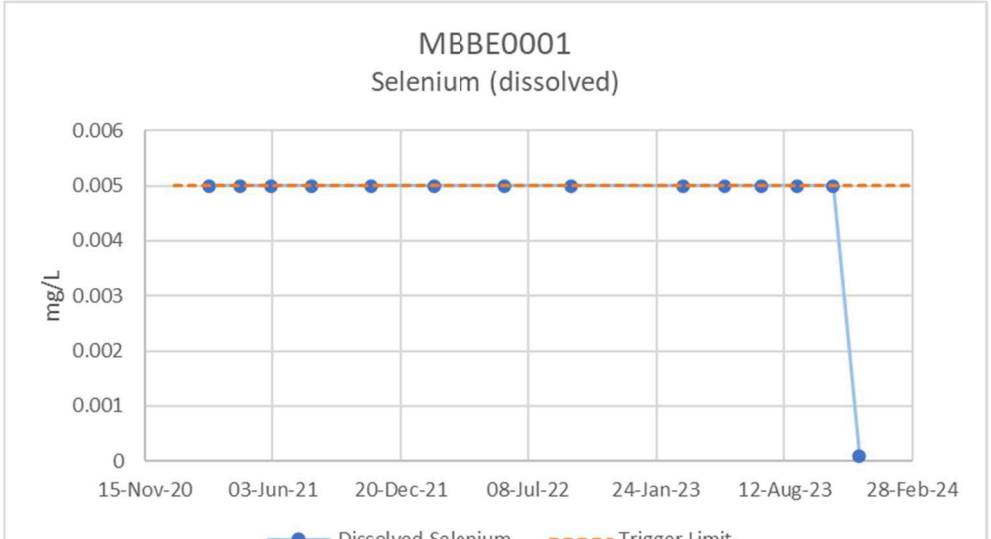

20-Dec-21
08-Jul-22
24-Jan-23
12-Aug-23
28-Feb-24
Lab pH
Trigger Limit


MBBE0001
Arsenic (dissolved)
20-Dec-21
08-Jul-22
24-Jan-23
12-Aug-23
28-Feb-24
Dissolved Arsenic
Trigger Limit


MBBE0001
Molybdenum (dissolved)
20-Dec-21
08-Jul-22
24-Jan-23
12-Aug-23
28-Feb-24
Dissolved Molybdenum
Trigger Limit


0.6
0.5
0.4
0.3
0.2
0.1
0
mg/L
15-Nov-20
03-Jun-21
20-Dec-21
08-Jul-22
24-Jan-23
12-Aug-23
28-Feb-24
Sulfate (SO4)
Trigger Limit


MBBE0001
Aluminium (dissolved)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
mg/L
15-Nov-20
03-Jun-21
20-Dec-21
08-Jul-22
24-Jan-23
12-Aug-23
28-Feb-24
Dissolved Aluminium
Trigger Limit


MBBE0001
Selenium (dissolved)
0.006
0.005
0.004
0.003
0.002
0.001
0
mg/L
15-Nov-20
03-Jun-21
20-Dec-21
08-Jul-22
24-Jan-23
12-Aug-23
28-Feb-24

MBBE0007

Groundwater quality data from February 2021 to February 2024 for compliance bore MBBE0007 indicates a slight increase in sulfate (SO_4). The minimum and maximum over this period are 850 mg/L and 1,060 mg/L respectively.

The sulfate concentrations and the current water quality trigger limit are shown in Figure 4.3 and a summary of the results for analytes as listed in Table D2 of the EA for this bore is shown in Table 4.4 (values in exceedance of water quality trigger limit as stipulated in EA highlighted in **red**).

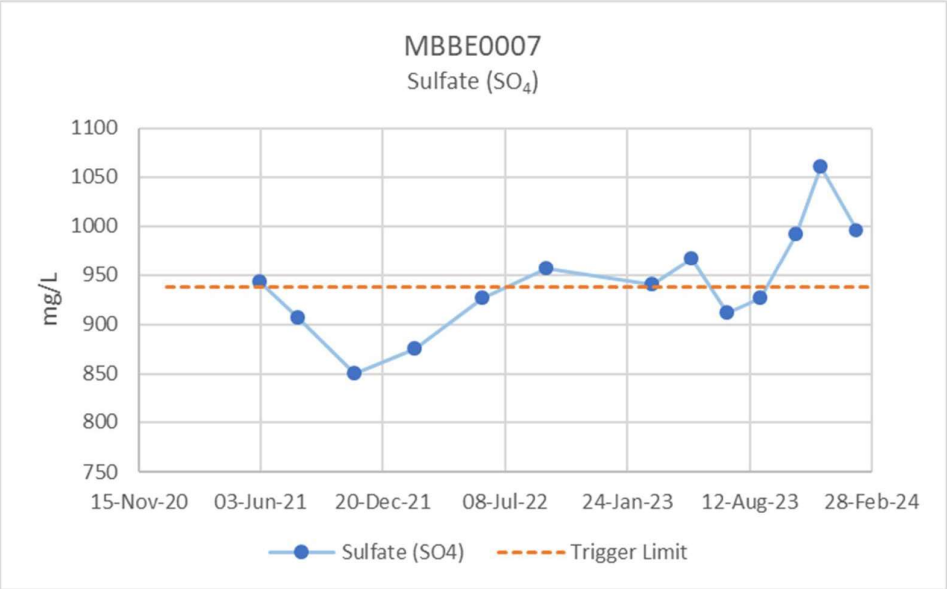
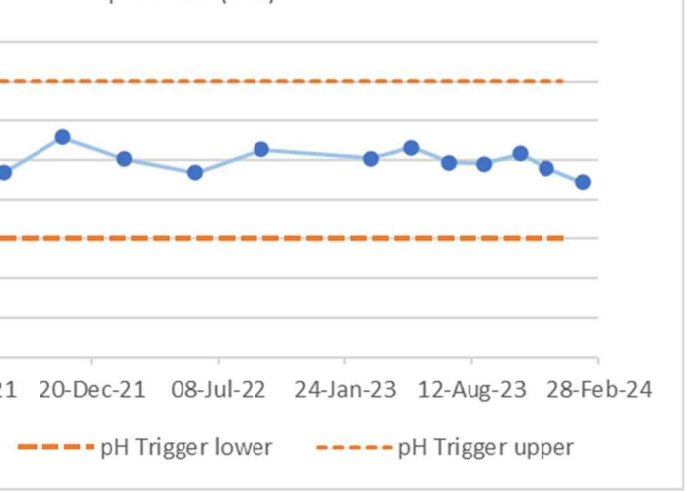
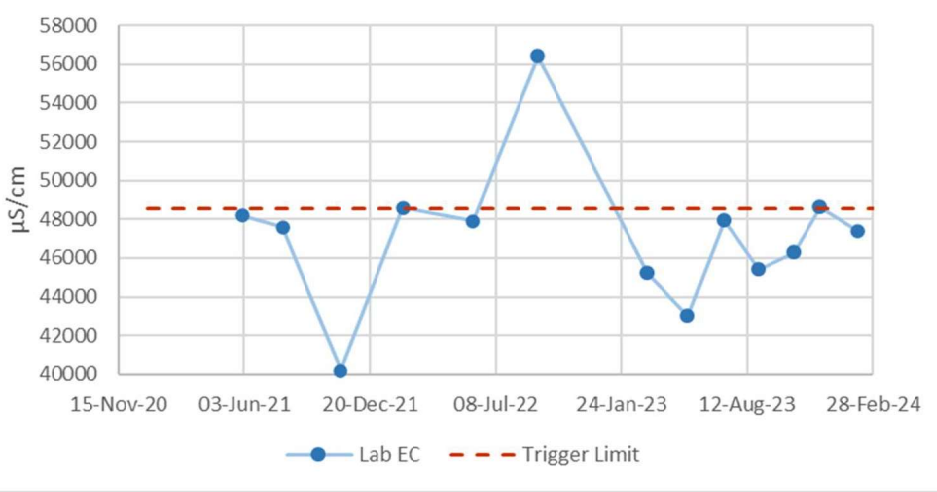


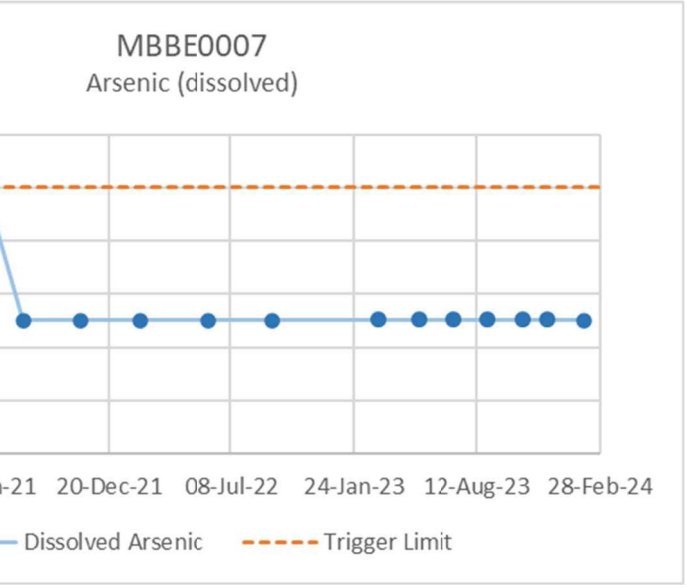
Figure 4.3 Sulfate for compliance bore MBBE0007 for total monitoring period

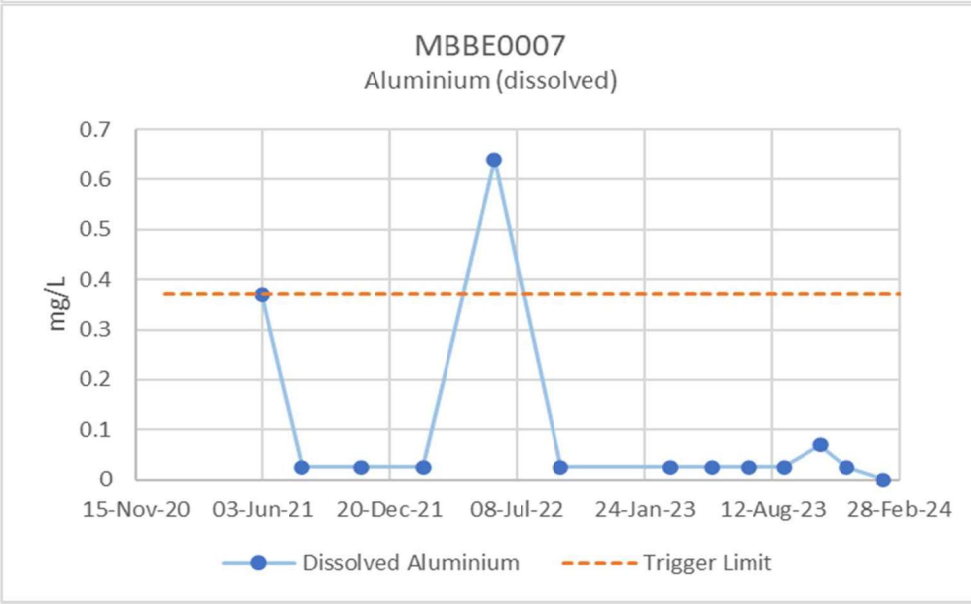
Table 4.4 Laboratory results for water quality triggers (as per Table D2 EA0002465) for MBBE0007 over monitoring period

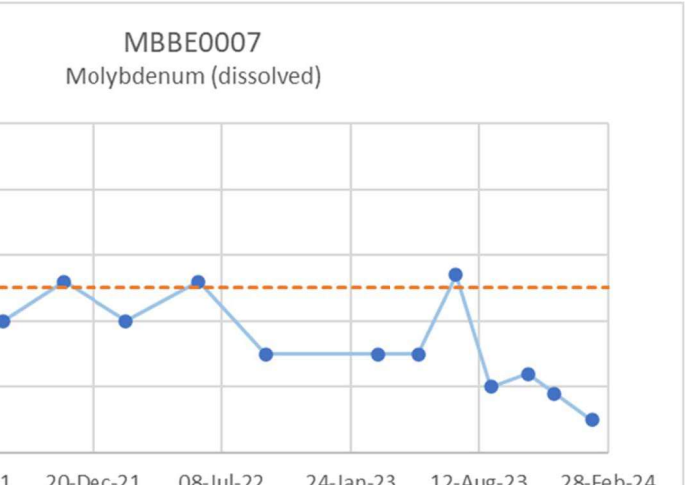
Trigger Parameter	Unit	MBBE0007												
		June 2021	Aug 2021	Nov 2021	Feb 2022	June 2022	Sept 2022	March 2023	May 2023	July 2023	Aug 2023	Oct 2023	Dec 2023	Feb 2024
pH	pH units	7.53	7.34	7.79	7.51	7.34	7.63	7.52	7.66	7.47	7.45	7.58	7.4	7.22
Electrical Conductivity	µs/cm	48,200	47,600	40,200	**48,600**	47,900	**56,400**	45,200	43,000	47,900	45,400	46,300	**48,600**	47,400
Sulfate	mg/L	**943**	907	850	876	926	**956**	**940**	**966**	912	927	**991**	**1060**	**996**
Arsenic	mg/L	<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
Aluminium	mg/L	0.37	<0.05	<0.05	<0.05	0.64	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05
Molybdenum	mg/L	0.021	0.02	0.026	0.02	0.022	0.015	0.015	0.015	0.027	0.01	0.012	0.009	0.005
Selenium	mg/L	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.002	<2

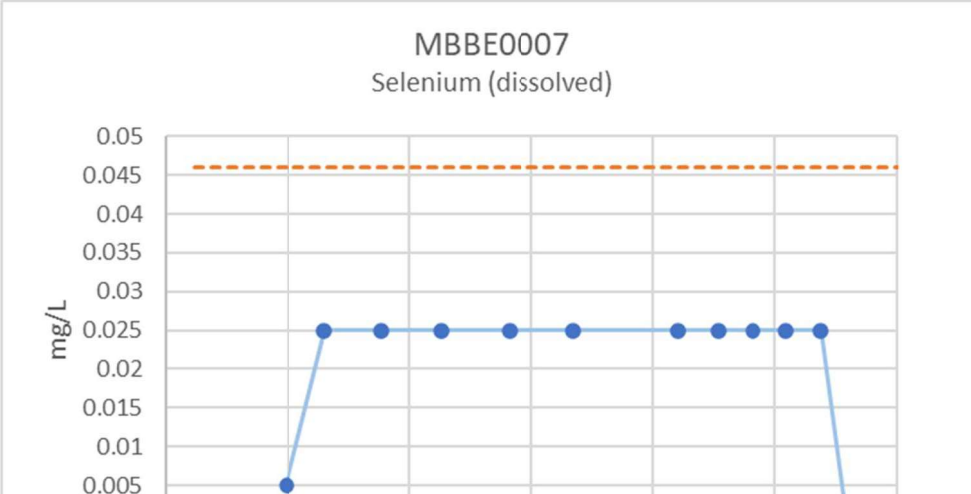

21
20-Dec-21
08-Jul-22
24-Jan-23
12-Aug-23
28-Feb-24
pH Trigger lower
pH Trigger upper


58000
56000
54000
52000
50000
48000
46000
44000
42000
40000
µS/cm
15-Nov-20
03-Jun-21
20-Dec-21
08-Jul-22
24-Jan-23
12-Aug-23
28-Feb-24
Lab EC
Trigger Limit


MBBE0007
Arsenic (dissolved)
-21
20-Dec-21
08-Jul-22
24-Jan-23
12-Aug-23
28-Feb-24
Dissolved Arsenic
Trigger Limit


MBBE0007
Aluminium (dissolved)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
mg/L
15-Nov-20
03-Jun-21
20-Dec-21
08-Jul-22
24-Jan-23
12-Aug-23
28-Feb-24
Dissolved Aluminium
Trigger Limit


MBBE0007
Molybdenum (dissolved)


MBBE0007
Selenium (dissolved)
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
mg/L

4.2 Updated Groundwater Monitoring Network

The current network as stipulated in Table D1 of EA includes 11 monitoring bores screened in five hydrostratigraphic units at varying depths.

Recent changes were made to the network:

- Various monitoring bores were mined through due to the progression of mining activities.
- Drilling of four (4) replacement bores in Q4 2023.

The updated BME monitoring network now consists of 10 monitoring bores screened in five hydrostratigraphic units at varying depths. The updated network is presented in Figure 4.5 and summarised in Table 4.5.

One of the current compliance bores, MBBE0001, is planned to be decommissioned in 2024 and replaced by bore MBBE0009 at that time. From December 2023, until monitoring is stopped at MBBE0001, these two bores are monitored concurrently to ensure continuous records for EA compliance.

Table 4.5 Updated Monitoring Bore Network Details and Monitoring Requirements Q1 2024

Monitoring Point	Easting (GDA20)	Northing (GDA20)	Screened Interval (mbgL*)	Aquifer / Monitored Interval	TOC[3] elevation (mAHD)[4]	Monitoring Frequency		Comments
						Quarterly	Six monthly	
Updated EA Monitoring Bores								
MBBE0002b[1]	618436	7585329	10.0 to 13.0	Tertiary Sediments	323.7	pH and EC	All other analytes	Ongoing
MBBE0003[1]	618431	7584664	4.0 to 7.0	Basalt	345.7	pH and EC	All other analytes	Ongoing
MBBE0004[1]	620205	7586976	2.0 to 5.0	Alluvium	290.8	pH and EC	All other analytes	Ongoing
MBBE0008	620294	7585092	130.0 to 133.0	Rangal Coal Measures	305.2	pH and EC	All other analytes	Ongoing
MBBE0010[5]	620362	7586723	52.0 to 58.0	Rewan Group	292.39	pH and EC	All other analytes	Monitoring started Oct 2023
MBBE0011[5]	619058	7587386	3.0 to 6.0	Alluvium	285.13	pH and EC	All other analytes	Monitoring started Oct 2023
MBBE0012[5]	619797	7584702	51.0 to 57.0	Rangal Coal Measures	336.42	pH and EC	All other analytes	Monitoring started Oct 2023
Compliance Bores								
MBBE0001[2]	619884	7585428	63.0 to 66.0	Rangal Coal Measures	305.2	pH and EC	All other analytes	Ongoing until mined through
MBBE0009[5]	620376	7586716	104.0 to 110	Rangal Coal Measures	292.46	pH and EC	All other analytes	Monitoring started Oct 2023.
MBBE0007	620615	7586415	40.0 to 46.0	Rewan Group	297.9	pH and EC	All other analytes	Ongoing
Surrounding Bores								
MBBE0005[1]	620519	7586210	4.0 to 7.0	Rewan Group	297.1	Not sampled		Ongoing

1. Some bores are often dry and unavailable for water levels.
2. MBBE0001 to be replaced by MBBE0009, already drilled in Oct 2023. Continue monitoring of both until MBBE0001 is mined out (2024).
3. TOC – top of casing.
4. mAHD – meters above Australian Height Datum
5. Replacement monitoring bores (Drilled October 2023)

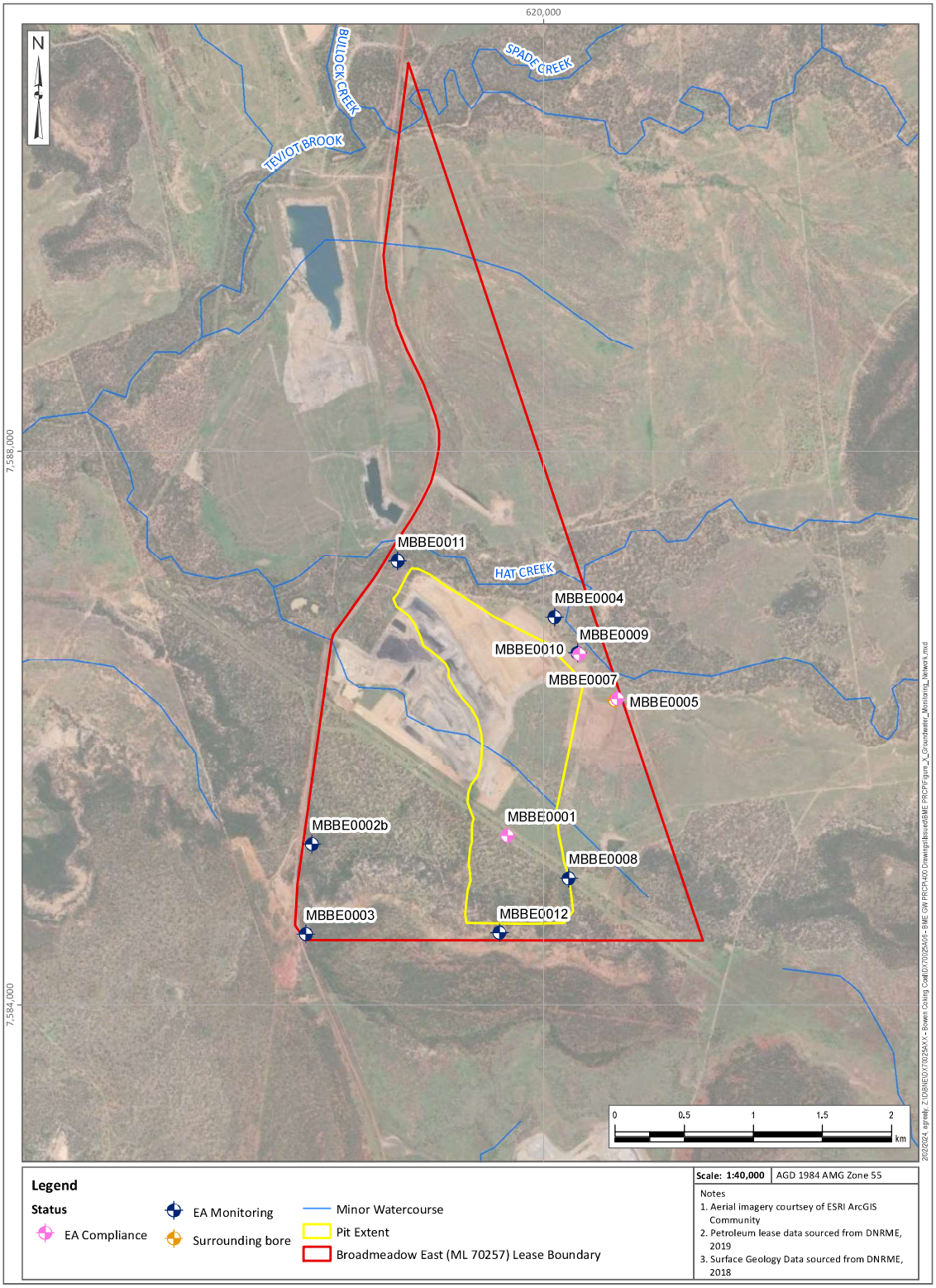


Figure 4.5 Updated Groundwater Monitoring Network (as in Q1 2024)

5 INVESTIGATION TRIGGER VALUES

5.1 Overview

The DES 2021 Guideline explains that *'trigger values are typically the numerical criteria that, if exceeded, provide an alert of a change that warrants further investigation for the contaminant being measured'.*

The Guideline offers two alternative methods: 'default values' or 'site-specific'. Where sufficient data is available, the site-specific approach is preferred, and this is the approach adopted for BME. The Guideline explains that groundwater quality can be highly variable. The variability can be influenced by local geology, residence time in the aquifer and groundwater-rock interactions, which can result in naturally elevated concentrations (e.g. salinity), dissolved nutrients and metals. As groundwater quality can be variable, the Guideline states that the use of 'default' values, such as those derived from the Queensland Water Quality Guidelines (DEHP 2013), and Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) for the protection of freshwater aquatic ecosystems or stock drinking water and the Australian Drinking Water Quality Guidelines (NHMRC 2018) 'may not always be appropriate' (page 1). In these cases, site-specific values should be calculated which are aquifer-based and operational area-defined, as these are considered more representative.

The DES guidance document (2021) identifies that:

> *"Trigger values should be fit for purpose and conservative enough such that, when applied, they provide an early warning of emerging potential impacts to groundwater. Applying triggers that are set too high may not be sensitive enough to identify current or emerging contamination issues. Conversely, if triggers and limits are set too low, natural variability may be mistaken for contamination events and result in unnecessary reporting and investigation."*

5.2 Methodology

This assessment was undertaken in a manner that is consistent with the DES guidance document (2021). An approach has been adopted that considers the site-specific conditions and is targeted towards understanding trends, providing BME with appropriate triggers to initiate actions.

DES (2021) recommends that groundwater quality assessment be based on comparing a number of consecutive sample tests at investigation trigger bores to a limit based on percentile calculations. This approach is aimed at reducing the probability of a false positive whilst ensuring that the approach is sufficiently sensitive to detect potential impacts.

5.2.1 Adoption of Percentiles

The approach is based on combining the ANZECC 2000 methodology, adapted control charting approaches, and statistics. The approach includes the calculation of the following:

- Limit - maximum (95th percentile) of existing time series monitoring data.
- pH limits based on ANZECC freshwater aquatic ecosystem trigger value (ANZG 2018).

5.2.2 Data Used to Develop Trigger Levels

The following approach was used to develop the trigger levels:

- All monitoring data from January 2021 to February 2024 was compiled into one data set for consideration.
- Anomalous values or outliers were removed for individual bores prior to calculation of the trigger value (consistent with guidance provided by DSITI 2017).
- If <50% of the dataset were non-detects (under the Limit of Recognition (LoR)) the non-detect values were set at half of the detection concentrations.
- If >50% of the dataset were non-detects (under the LoR), these values were removed from the dataset before site-specific triggers were calculated on the remaining data.
- If there are less than eight (<8) data points available that are greater than LoR, the guidelines recommend using the default or WQO until sufficient data is collected to calculate a site-specific value.
- If there are no default guidelines for a given analyte or if the default guideline is less than the LoR, KCB recommends the LoR to be used as the trigger limit until sufficient data is collected to calculate a site-specific value.
- If more than one species (e.g. As(III) and AS(V)) and we don't know which one the laboratory will analyse, then the more stringent of the default values is set as trigger value.

5.3 Groundwater Contaminant Triggers

The 'source-pathway-receptor' approach has been adopted to assess the need for trigger values in accordance with the guidelines wherein site activities, the hydrogeological environment and identified environmental receptors are considered. This approach reviews environmental values, available data and existing groundwater quality changes to choose appropriate groundwater quality trigger levels.

The primary source of potential contaminants associated with the Project may include spoil dumps and surface water management facilities. However, throughout the duration of Project operation, and during mine closure, groundwater flow will be towards the proposed pit / post-closure pit voids (KCB 2023). This is due to dewatering activities associated with the pit development causing a drawdown in the local groundwater regime; and the final post-closure groundwater equilibrium level resulting in the development of a localised groundwater sinks in vicinity of the Project area. Therefore, throughout operation of the Project, and into mine closure, there will be no groundwater flow pathway from the Project area to downstream receptors.

The parameters chosen for trigger development (pH, EC, SO_4, Al, As, Fe) are appropriate for the contaminants of concern for coal mining operations.

Table 5.2 provides a summary of all the data points used in the calculation of the trigger limits for compliance bores MBBE0001 and MBBE0007.

The initial calculated groundwater quality trigger values for the indicator parameters for the monitoring bores are shown in Table 5.3 and are based on the monitoring data collected at the

specific bores between January 2021 to February 2022. This has been taken up in the EA of 3 February 2023.

Since February 2022, additional water quality data has become available. These results have been evaluated and trigger values updated where applicable according to the DES 2021 guideline document. These updated triggers are summarised in Table 5.4.

The WQOs for the Isaac River Groundwaters (Zone 34) have been identified for both the shallow (<30 m) and deep systems (>30 m) (DEHP, 2011).

The ANZG default water quality guidelines for the groundwater quality parameters have been identified for aluminium, silver, arsenic, mercury, antimony, molybdenum, and selenium based on a moderately disturbed system. These are presented in Table 5.1.

There are no default water quality guidelines or objectives for potassium, carbonate, and total petroleum hydrocarbons (TPH).

Table 5.1 Default Guidelines and WQOs for Key Analytes

Indicator	Default Guidelines and WQOs						
	ANZG Default (mg/L) (Slightly to Moderately Disturbed – 80th percentile)	Isaac River Groundwaters (Zone 34)					
		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 (uS/cm)		498	2150	8910	3419	6100	16000
Calcium (mg/L)		18	84	215	46	145	442
Magnesium (mg/L)		27	108	389	35	115	491
Sodium (mg/L)		135	747	1500	480	1100	2565
Potassium (mg/L)		-	-	-	-	-	-
Chloride (mg/L)		171	1309	3185	753	1900	5905
Sulphate (mg/L)		12	140	318	25	138	398
Carbonate (mg/L)		-	-	-	-	-	-
Bicarbonate (mg/L)		187	536	878	188	330	650
Iron (mg/L)		0.000	0.030	0.140	0.000	0.050	0.246
Aluminium (mg/L)	0.055*	-	-	-	-	-	-
Silver (mg/L)	0.00005*	-	-	-	-	-	-
Arsenic (mg/L)	0.013*^	-	-	-	-	-	-
Mercury (inorganic) (mg/L)	0.00006#	-	-	-	-	-	-
Antimony (mg/L)	0.009	-	-	-	-	-	-
Molybdenum (mg/L)	0.034	-	-	-	-	-	-
Selenium (mg/L)	0.005#	-	-	-	-	-	-
Total Petroleum Hydrocarbons (ug/L)	-	-	-	-	-	-	-

* 95% level of species protection recommended for slightly to moderately disturbed ecosystems.

^ The ANZG 2018 specify different toxicant trigger values for arsenic Arsenite As(III) and Arsenate As(V); when the speciation of arsenic is unknown, as in this case, the more conservative trigger value (Arsenate As(V)) should be used.

\# To account for the bioaccumulating nature of this toxicant, it is recommended that the 99% species protection level DGV is used for slightly to moderately disturbed systems.

Table 5.2 Summary of data point statistics for compliance bore trigger calculations

Compliance Parameter	pH	EC	Sulfate (SO4)	Aluminium (dissolved)	Arsenic (dissolved)	Molybdenum (dissolved)	Selenium (dissolved)
MBBE0001							
Amount of data points on 23 Feb 2024	16	16	16	16	16	15	14
Limit of Reporting	0.01	1	0.1*	0.01	0.001	0.001	0.01
% of dataset <LoR	0	0	100	25	56	73	100
Amount of data points usable	16	14	0	12	7	4	0
Other reason for exclusion of data point-/s		2 outliers					
Proposed Trigger	**6.5 - 8.5**	**901.7**	**Default***	**0.08**	**Default***	**Default***	**Default***
MBBE0007							
Amount of data points on 23 Feb 2024	13	13	13	13	13	13	13
Limit of Reporting	0.01	1	0.1*	0.01	0.001	0.001	0.01
% of dataset <LoR	0	0	0	76	92	7	84
Amount of data points used	13	12	10	3	1	12	1
Other reason for exclusion of data point-/s		Outlier	Outliers, rain dilution				Outlier
Proposed Trigger	**6.5 - 8.5**	**48,600**	**961.5**	**Default***	**Default***	**0.02**	**Default***

*If >50% of the dataset were non-detects (under the LoR), these values were removed from the dataset before site-specific triggers were calculated on the remaining data. If less than 8 points then available, the default or WQO is allocated as trigger until sufficient data (>8 points) are available.

Table 5.3 Current Groundwater Quality Trigger Values (Table D-2 from EA)

Monitoring Point	Parameter	pH	EC	Sulfate (SO_4)	Arsenic	Aluminium	Molybdenum	Selenium	Major ions
	Sample	Range	Max	Max	Max	Max	Max	Max	
	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	Interpretation Only
MBBE0007			48,540	937.6	0.005	0.37	0.025	0.046	

Table 5.4 Proposed Groundwater Quality Trigger Values

Monitoring Point	Parameter	pH	EC	Sulfate (SO_4)	Arsenic	Aluminium	Molybdenum	Selenium	Major ions
	Sample	Range	Max	Max	Max	Max	Max	Max	
	Unit	pH units	(µS/cm)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
MBBE0001		6.5 – 8.5	901.7	398*	0.013*	0.08	0.034*	0.013*	Interpretation Only
MBBE0007			48,600	961.5	0.013*	0.055*	0.02	0.013*	
MBBE0009			16,000*	398*	0.013**	0.055**	0.034**	0.005**	

*default WQO value
**default values ANZECC/ARMCANZ (2000)

5.4 Groundwater Level Triggers

KCB developed a numerical groundwater model for the BME project site in September 2023 as part of the Progressive Rehabilitation and Closure Plan (PRCP). After calibration of the model, groundwater level predictions were done for different times during mining operations, as well as post-closure. Maximum drawdown levels for each hydrostratigraphic unit are shown in Figure 5.1 to Figure 5.5.

These model results were used to determine maximum drawdown for the newly drilled bores, MBBE0009, MBBE0010, MBBE0011 and MBBE0012. Recommended groundwater level triggers are summarised in Table 5.5. Groundwater trigger levels for BME compliance bores have also been updated and these are presented in Table 5.6.

No pre-mining baseline standing water level can be allocated to MBBE0011 since the bore was dry after construction and subsequent monitoring rounds confirmed the absence of groundwater in the bore.

Table 5.5 Predicted Groundwater Levels with Proposed Trigger Levels

Purpose	Bore ID	Ground level elevation (mAHD)	Bore depth (meters below surface)	Baseline SWL (mbTOC)	Groundwater Trigger Elevation* (mAHD)
Investigation Trigger	MBBE0010	291.63	58	21.36	267.23
Investigation Trigger	MBBE0011	284.34	8	N/A	N/A
Investigation Trigger	MBBE0012	335.72	58	46.43	280.23

N/A – Not Applicable, bore dry
*based on numerical model predictions for maximum drawdown

Table 5.6 Proposed Groundwater Trigger Levels for Compliance Bores

Purpose	Bore ID	Ground level elevation (mAHD)	Bore depth (meters below surface)	Baseline Water Level (mbTOC)	Baseline Water Level (mAHD)	Groundwater Trigger Elevation* (mAHD)
Compliance Bore	MBBE0001	304.5	67.6	17.11	288.1	241
Compliance Bore	MBBE0007	297.10	52	18.22	279.6	273
Compliance Bore	MBBE0009#	291.65	166	24.74**	266.1	267.48

* Based on numerical model predictions for maximum drawdown
**Used first recorded manual dip water level after bore drilled and before mining commenced
to replace MBBE0001 as Compliance Bore in future

It is recommended that the EA be amended so that any exceedance of the predicted maximum groundwater drawdowns be used as trigger values to indicate excessive drawdown. The groundwater model is conservative, and therefore, the predicted maximum drawdown values should not be reached under currently anticipated conditions. To avoid false triggering, triggers for groundwater levels are defined to occur when average values exceed the groundwater trigger elevation for three or more consecutive monitoring rounds.

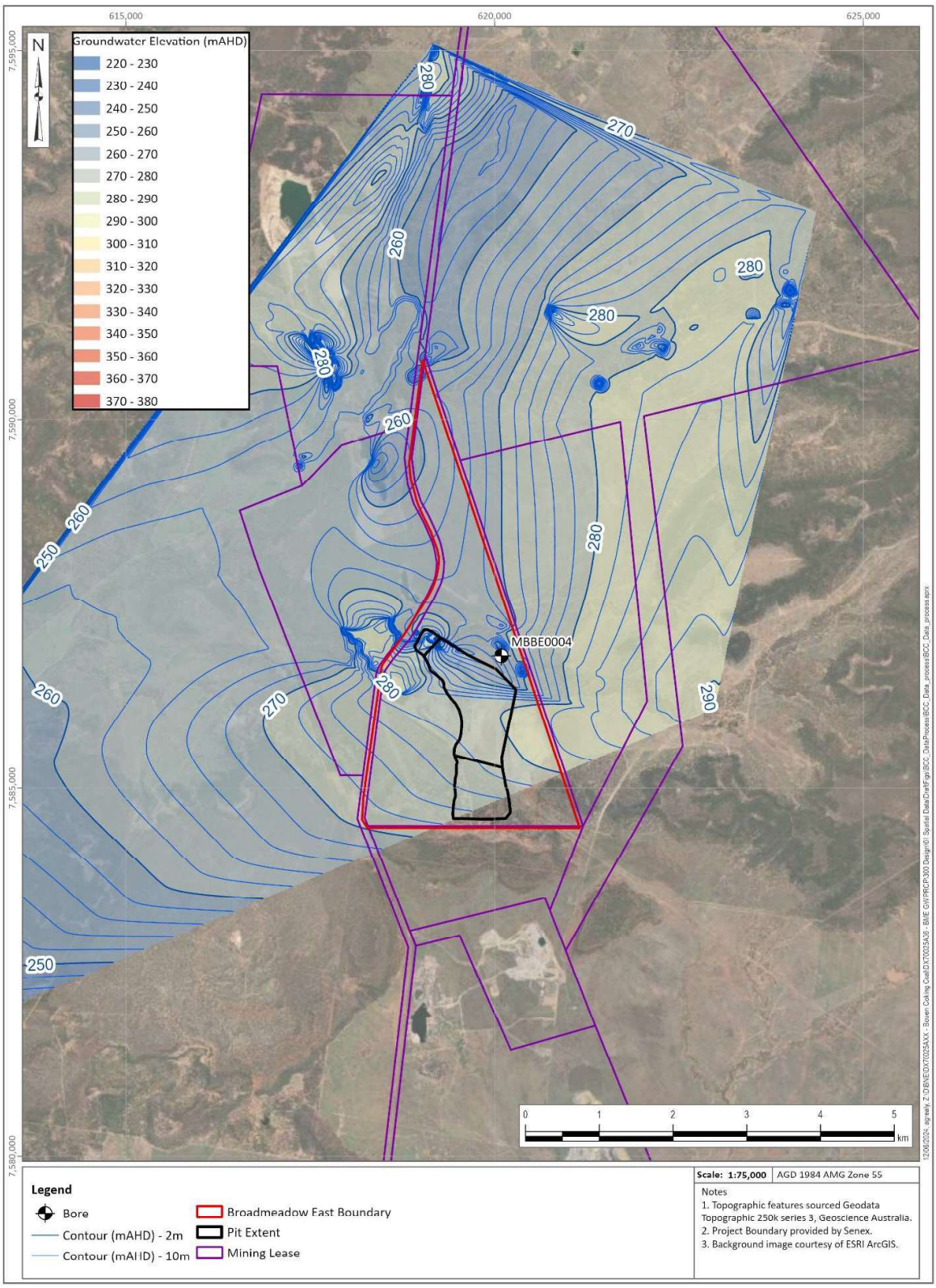


Figure 5.1 Predicted Maximum Drawdown Elevation in Layer 1 – Quaternary Alluvium

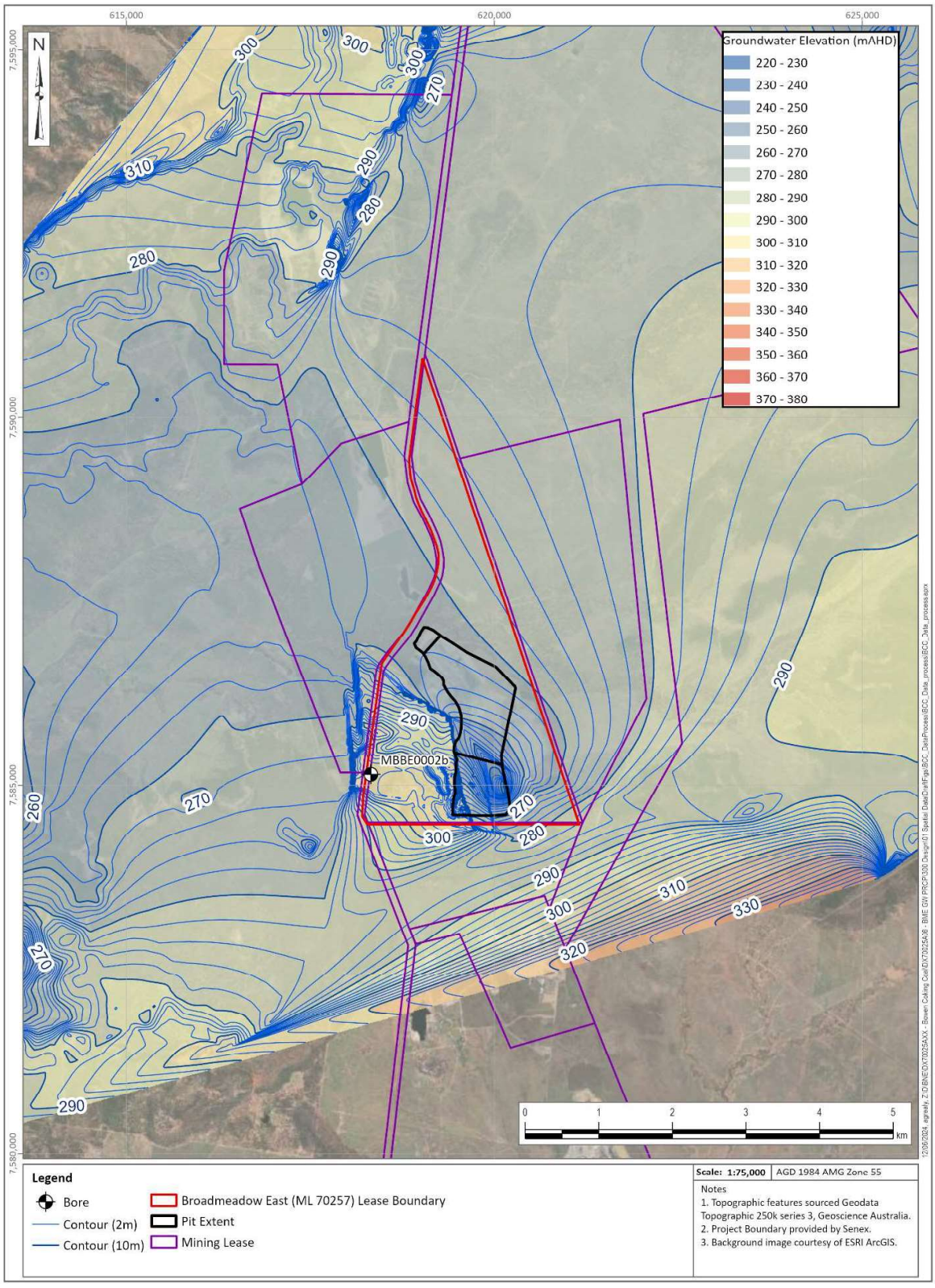


Figure 5.2 Predicted Maximum Drawdown Elevation in Layer 2 – Tertiary Sediments

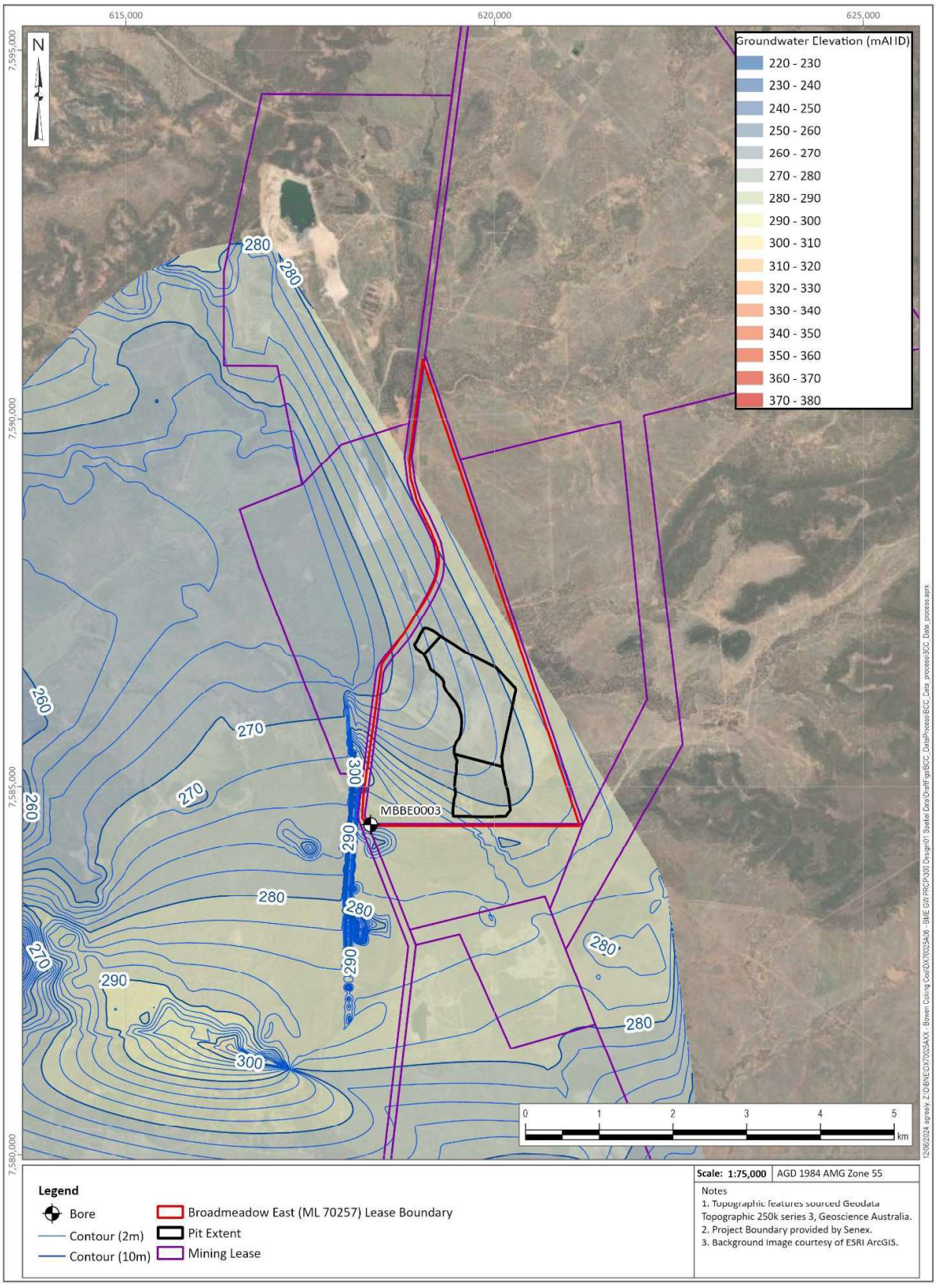


Figure 5.3 Predicted Maximum Drawdown Elevation in Layer 3 – Tertiary Basalt

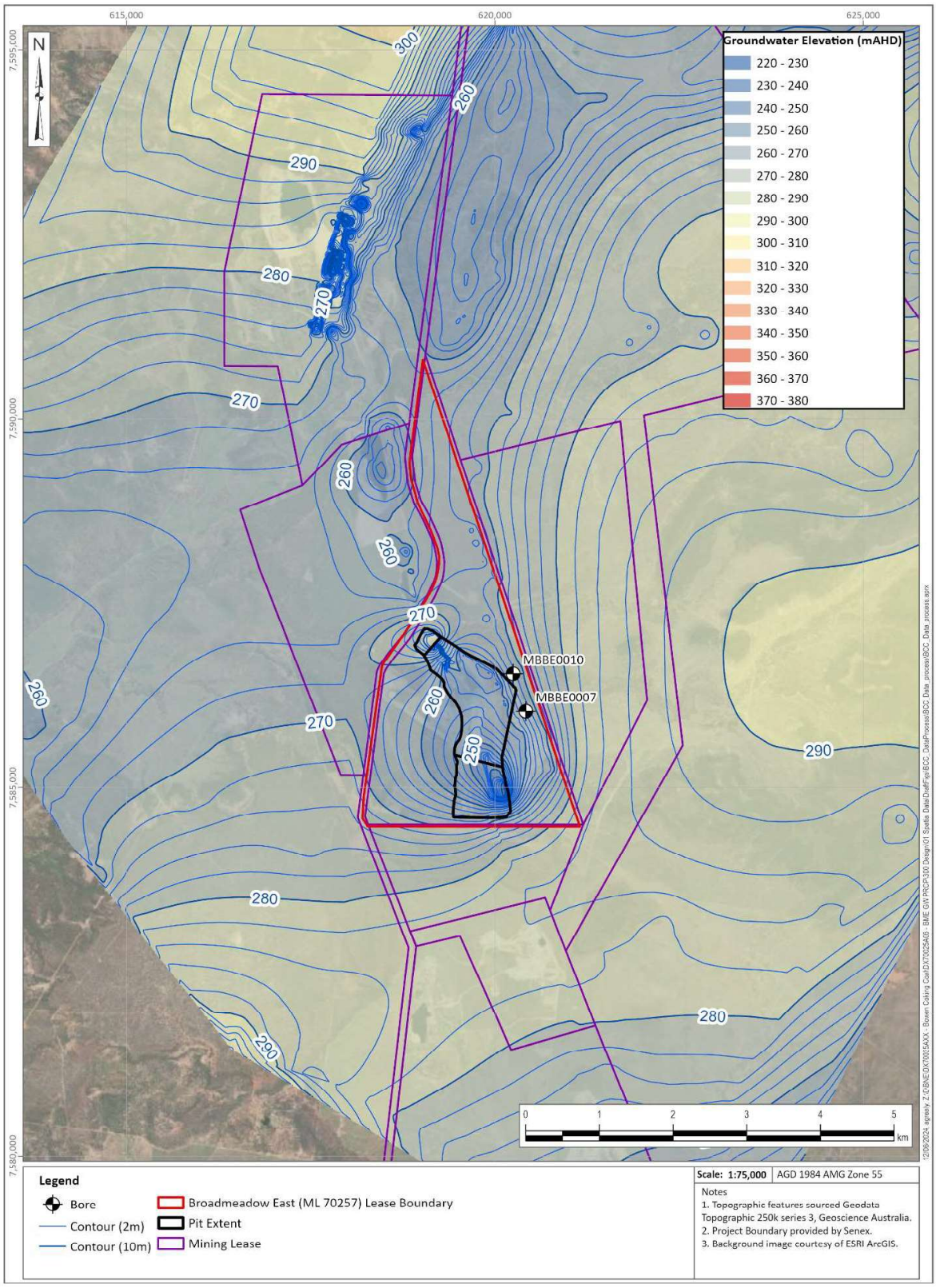


Figure 5.4 Predicted Maximum Drawdown Elevation in Layer 4 – Rewan Group

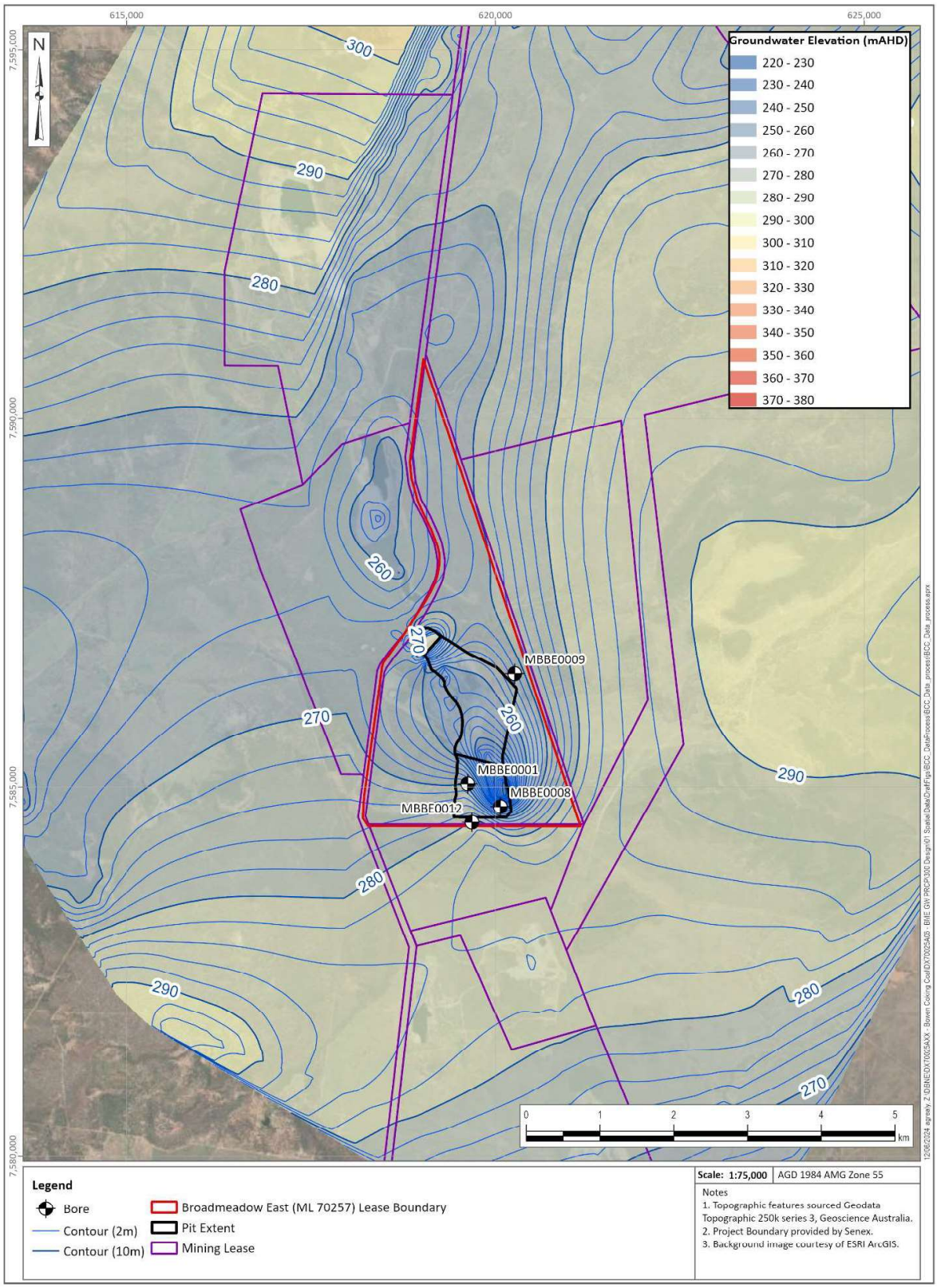


Figure 5.5 Predicted Maximum Drawdown Elevation in Layer 5 – Rangal Coal Measures

6 SUMMARY AND RECOMMENDATIONS

This technical memorandum was compiled to assist BCC in the compilation of an EA Amendment application.

The following triggers – with specific reference to compliance bores MBBE0001 and MBBE0007 - were evaluated and updated where applicable in this document:

- Groundwater quality (based on bore-specific water quality monitoring data); and
- Groundwater levels (based on model predictions of the expected changes).

MBBE0007 Summary

- The sulfate concentration shows an increasing trend from July 2023 to December 2023. The latest result shows a decline in the concentration, but the concentration still exceeds the trigger limit. The increasing trend could be due to impact from mining activities (spoil and overburden dump leachate).
- The 2021 DES guideline states "*The time series data should also be analysed for trends. If a trend, either upward or downward, is detected then the groundwater may be impacted. In general, data with values increasing over time should not be used to calculate site-specific groundwater guidelines".*
- An increasing trend in the data may indicate contamination of the groundwater and should be investigated. The latest monitoring event in February 2024 shows a decline in the EC concentration.
- An update for the water quality trigger limit considered 10 of the 13 available data points; excluding two outliers and the most recent data result that seems to be influenced by high rainfall events.
- Arsenic, aluminium and selenium have less than 8 data points available for trigger calculation. All three analytes have a very large part (76 to 92%) of their dataset values reported as below Limit of Reporting.

MBBE0007 Recommendations

- Update the sulfate (SO_4) water quality trigger limit to 961.5 mg/L.
- Update the electrical conductivity (EC) water quality trigger limit to 48,600 µS/cm.
- Update aluminium, arsenic and selenium water quality triggers to reflect the default water quality guideline values.

MBBE0001 Summary

- The electrical conductivity concentrations have exceeded the trigger limit of the total monitoring period. These limits were originally calculated on only a few data points, but additional data points have since become available to include in the statistical calculations.
- Sulfate, arsenic, molybdenum and selenium have less than 8 data points available for trigger calculation. All three analytes have a very large part (56 to 10%) of their dataset values reported as below Limit of Reporting.

MBBE0001 Recommendations

- Adjust the electrical conductivity (EC) quality trigger to 901.7 µS/cm, based on the additional chemistry results that are available since previous trigger calculations.
- Update sulfate (SO_4), arsenic, molybdenum and selenium water quality triggers to reflect the default water quality guideline values.

New Monitoring Bores

Additional monitoring bores were drilled in October 2023 to update the existing network after some EA monitoring bores were decommissioned as a result of the progression of approved mining activities.

The following are the main recommendations for these new replacement bores:

- Water Quality sampling at the newly drilled 2023 bores should initially be done at a bi- monthly frequency.
- Once sufficient water quality data is available (minimum 8 sampling events within one full calendar year of data), triggers should be set for the new 2023 bores.
- Default Water Quality Guideline values (ANZECC & ARMCANZ, 2000) should be used as temporary groundwater quality trigger parameters for MBBE0009. The parameters pH, EC, SO_4, Al, As, Se, Mo are recommended as appropriate triggers for the contaminants of concern for coal mining operations (see summary in Table 5.1). Data analysis results for two (2) sampling events at MBBE0009 differ substantially from MBBE0001 and therefore it is not recommended that trigger limits are inferred, even though the two bores are screened in the same aquifer.
- The groundwater model should be verified and potentially updated with the new bore drilling and data collection.
- Bore MBBE0011 cannot be assigned a pre-mining baseline standing water level, since no groundwater was encountered, and the bore is considered dry. This approach has also been followed in the previous Amendment of EA0002465.

New Monitoring Bore Recommendations

- Groundwater levels trigger values for all four replacement bores are recommended based on the maximum drawdown predicted from the numerical groundwater model (KCB 2023).
- Default WQO guideline values (ANZECC & ARMCANZ, 2000) should be assigned to MBBE0009 (future compliance bore) as temporary groundwater quality triggers, until at least eight (8) sampling event results are available. Then bore-specific triggers should be calculated for the four bores.

The recommended trigger values should be applicable through operation into post-closure. An update of the trigger levels for both quality and water level will be required once sufficient data points (minimum of 8) become available.

7 CLOSING

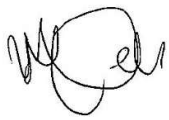
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